MASS SPECTROMETER LEAK TEST STATIONS

Models MS-17A MS-17AB, MS-17ABC

OPERATION AND MAINTENANCE MANUAL

Veeco® INSTRUMENTS INC.

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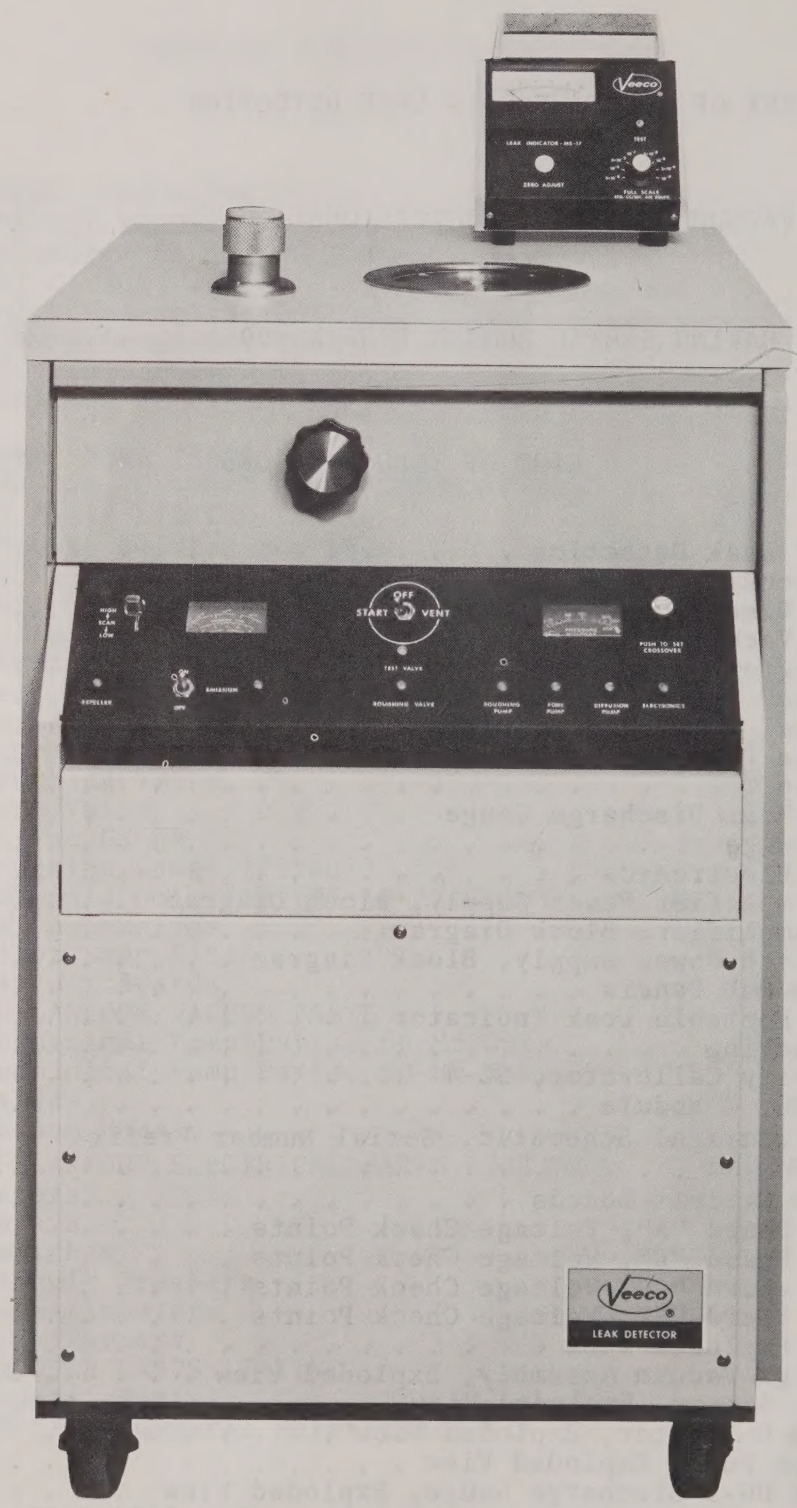


Frontispiece - MS-17AB Leak Test Station

Section I

INTRODUCTION

A. PURPOSE OF MANUAL

The primary purpose of this manual is to supply information and guidance to the personnel who will operate and maintain the VEECO MS-17A, AB and ABC. See Addendum for important supplementary information pertaining to units having serial number prefix-00.

In addition to complete information on installation, operation and maintenance, this manual provides a general discussion of the instrument's components and how they work for those who may have little or no knowledge of mass spectrometry leak detection.

Illustrations are included for the operator to locate operational and adjustable controls and for the troubleshooter to locate individual components of the machine and its circuits.

WARNING

LETHAL VOLTAGES OF UP TO 3300 VOLTS ARE PRESENT IN THE COLD CATHODE GAUGE OF THE LEAK DETECTOR. ONLY PERSONNEL TRAINED IN THE SAFEGUARDS FOR HANDLING HAZARDOUS VOLTAGES SHOULD SERVICE THIS EQUIPMENT. ONLY TECHNICIANS FAMILIAR WITH SOPHISTICATED ELECTRONIC CIRCUITS SHOULD ATTEMPT TO TEST OR REPAIR THE COMPONENTS.

B. GENERAL DESCRIPTION

The Veeco MS-17A is a basic Mass Spectrometer tuned to Mass 4 (helium). It has a complete vacuum system and all electronics necessary for the proper operation of the spectrometer tube.

The MS-17AB has all the parts of the MS-17A plus an auxiliary vacuum station necessary to put under vacuum the pieces which are to be tested for leaks.

The MS-17ABC has all the capabilities of the MS-17AB plus a back-fill capability.

All methods of leak detection involve the passage of a "tracer" from one side of a presumed leak to the other, and the subsequent detection of the tracer on the latter side. The mass spectrometer leak detector is the most sensitive and accurate instrument known for indicating extremely small leaks, by measuring the rate of flow of a "tracer" gas, usually helium, through the leaks.

SPECIFICATIONS

MS-17AB AUTOMATIC LEAK TEST STATION

PERFORMANCE

Sensitivity: 6×10^{-11} atm - cc/sec for air, at full pumping speed will produce a signal of 2% of full scale. Response time is less than 1.5 second. Smaller leaks can be found with accumulator valve partially shut. Performance determined in accordance with American Vacuum Society Standard T.S.2.1.

Noise Level: Less than 2% of full scale at maximum sensitivity range. Signal-to-noise ratio is one (1).

Amplifier Drift: All solid state electronics; drift is less than 1% of full scale per hour after 20 minute warm-up.

Pumping Speed: 10 liters per second air, 27 liters per second helium at the spectrometer tube flange, with accumulator valve completely open (at full pumping speed). Normal operating pressure is 1×10^{-5} torr. Maximum operating pressure is 3×10^{-4} torr.

Leak Range: 6×10^{-11} to 3×10^{-5} atm - cc/sec for air at full pumping speed; presented over 7 ranges. Larger leaks may be monitored using throttling techniques.

Test Time: 8 seconds with blanked port using 10.6 cfm roughing pump (optional). 9 seconds with 5.6 cfm roughing pump (standard).

PHYSICAL DATA

Size: 36⅛" high, 22¼" wide, 28⅛" deep. Top work surface is formica. All four sides easily removed. Self contained, front panel mounted solid state electronics. Four swivel casters provided for maximum mobility. Total weight is 400 pounds.

Test Inlet: Top inlet is a quick vacuum coupling for 1⅛" O.D. tube. One flanged side inlet port provided as an option (at extra cost).

CEE TUBE (Spectrometer Tube)

Dual sector mass spectrometer tube (double 60° deflection) completely eliminates unwanted background scattering effects and reduces background signal below the limit of detectability to provide a greatly improved signal to noise ratio. The helium ion beam exiting from the second magnet has an extremely high order of mass purity. Source and collector assemblies are flanged and self aligning. Patented self cleaning heated repeller continually heats spectrometer ion source preventing formation of condensible contaminants. Two non-warping, self-aligning tungsten ribbon filaments allow uninterrupted testing. Preamplifier tube CK 5886 mounted under vacuum for maximum electrometer stability. Neoprene O-rings prevent helium adsorption or permeability. Front panel mounted helium scan control assures positive helium identification by detuning ion accelerating voltage (plus and minus 10%) and indicates presence of background gases.

VACUUM SYSTEM

Mechanical Forepump: .9 CFM Welch Model 1400B mounted on vibration free platform.

Diffusion Pump: Veeco Model EP3AB, 170 l/s air-cooled 4 stage fractionating stainless steel body and thermo insulation collar. Fractionation assures that only the lowest vapor pressure fractions of the pumping fluid are fed to the top jet to give the highest possible vacuum. Foreline tolerance exceeds 500 microns. Optically dense foreline baffle minimizes loss of diffusion pump oil: EP3AB requires 120cc of Octoil.

Roughing Pump: 5.6 cfm Welch Model 1402B (standard) or 10.6 cfm Welch Model 1376B (optional) mounted on vibration free platform.

Cold Trap: Low loss stainless steel liquid nitrogen cold trap provides cryogenic pumping of condensibles. 2 liter capacity (12 hours under vacuum). Liquid nitrogen required only during test period. Heated ion source assures overnight self-cleaning action.

Valves: Sealed bellows, vacuum actuated pump and test valves are warranteed against defective workmanship for 1 million cycles. Spring loading construction provides positive fail safe sealing in event of power failure. Unibody manifold construction minimizes flanged or brazed joints and provides high pumping conductance. Throttling valve included in unibody construction. Accumulator valve is 1¼" diameter butterfly type. Solenoid type vent valve is provided.

Pressure Sensors: Cold cathode discharge gauge monitors high vacuum in 10^{-3} torr to 10^{-6} torr range. Gauge tube includes easily removed cathode liner to facilitate maintenance. Output is interlocked with filament and test valve to protect system against pressure bursts.

The Pirani pressure gauge monitors roughing pressure over 1 torr to 1×10^{-3} torr range with 20 millisecond response.

SOLID STATE ELECTRONICS

Self contained front panel mounted solid state electronics may be easily removed from vacuum system. Individual circuits on printed circuit boards. "Low Powered" solid state electronics are reliably air cooled. Large surface (17" x 6") filter assures low temperature operation. All mass spectrometer tuning controls located behind front service panel.

Leak Meter: Portable leak meter provides direct meter readout over range of 6×10^{-11} to 3×10^{-6} atm - cc/sec for air. Audio signal provided as option.

Power Requirements: 15 amps at 115 Volts, with 5.6 cfm pump (standard). 17 amps at 115 Volts, with 10.6 cfm pump (optional). 50 or 60 Hz as specified.

MS-17A MANUAL LEAK TEST STATION

The MS-17A is a manually operated leak test station without the automatic pump, test and vent valves and without the auxiliary roughing pump and pirani gauge control.

Valves: Manual throttle and accumulator valves are provided. Physical cabinet size is identical to MS-17AB.

Power Requirements: Approximately 8 Amps at 115 Volts, 50 or 60 Hz as specified.

MS-17ABC AUTOMATIC LEAK TEST AND BACKFILL STATION

The MS-17ABC consists of the MS-17AB Leak Test Station with the addition of the "C" block which provides evacuation and manual backfill facility. The "C" block is a self contained module designed to be added to the side of the MS-17AB.

Base Plate: The "C" module includes an 11" dia. stainless steel baseplate with "O" ring seal; plus a pyrex bell jar approx. 8" dia x 15" high.

Pump: Backfill and evacuation manifold includes a 2 cfm mechanical roughing pump, backfill gas toggle valves, one Bourdon Vacuum Gauge and a vacuum quick coupling inlet connection.

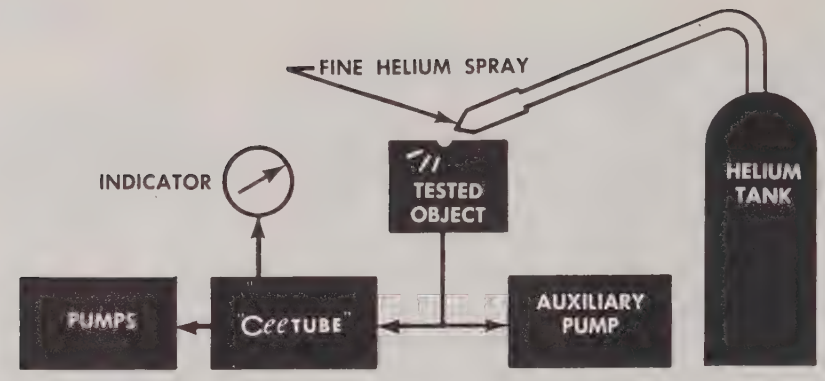
D. TYPES OF LEAK DETECTION (See Figure 1)

Fundamentally there are three types of leak detection. Vacuum Testing, Pressure Testing and Pressure-Vacuum (Inside-out) Testing, which can be performed with the Veeco "Cee Tube" helium mass spectrometer.

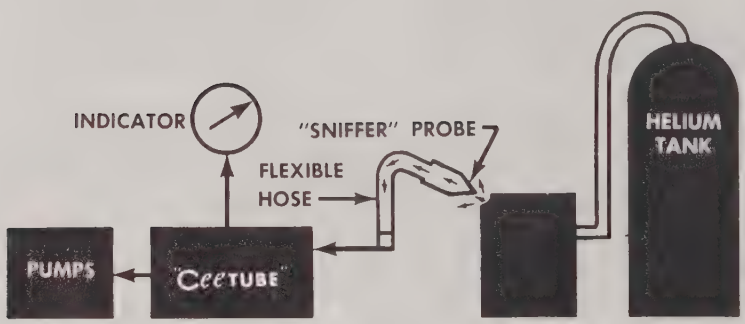
(1) Vacuum Testing. The Cee tube operates at a high vacuum, and therefore, is connected to a vacuum pumping system. The object to be tested is evacuated by an auxiliary pump as shown. A sample of the gas in the pumping line is passed to the Cee tube which is continuously being evacuated by its own pumps. The outside of the object is then sprayed with a fine jet of helium; if a leak does exist, the helium enters and is present in the pumping line and the Cee tube. Since the rare gas helium is present in insignificant amounts in air, helium will enter only when a leak has actually been "probed" with the gas. The Cee tube immediately converts the helium into an electrical indication. The exact location of leaks may be determined by "probing" with a fine jet spray of helium or, if desired, the whole object may be blanketed with helium gas in order to provide an overall test.

(2) Pressure Testing. In pressure testing, the helium is introduced within the test object under a pressure greater than atmospheric. A "sniffer" probe, is connected to the leak detector using a flexible rubber hose. When this sniffer is passed over a leak, the outflowing helium enters the system via the sniffer and is detected by the Cee tube. Pressure testing is useful for testing large tanks, or objects which cannot withstand internal vacuum; however, its sensitivity is less than that of vacuum testing since the "sniffer" admits some surrounding air which dilutes the helium tracer.

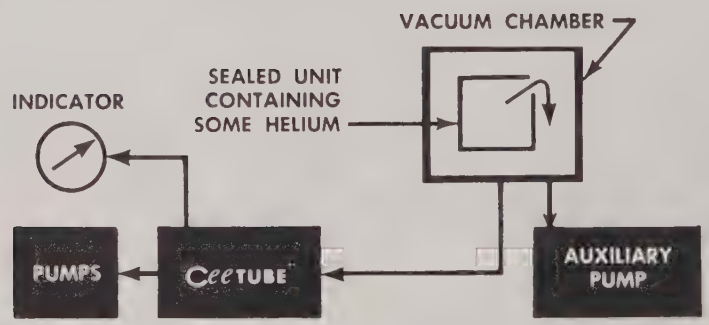
(3) Pressure-Vacuum Testing. Pressure testing may be combined with vacuum testing in such a way that units having an internal helium pressure may be tested at the high sensitivity which is inherent in vacuum testing. This may be done by placing the pressurized unit inside a vacuum chamber which is then connected to the leak detector. If a leak exists, helium will flow out of the unit under test, into the vacuum chamber, and thence to the Cee tube where it will be detected. Since the unit is surrounded by vacuum, no dilution occurs and maximum sensitivity results. This method is useful for the overall testing of hermetically sealed components such as relays, gyros, aviation instruments, switches, etc. VEECO provides equipment for evacuating and backfilling units of this kind. Block "C" of the MS-17 series provides a backfill capability.



Vacuum Testing



Pressure Testing



Pressure - Vacuum Testing

Figure 1. Types of Leak Detection

Section II

SYSTEM COMPONENTS

A. GENERAL (See Figure 2)

1. Cee Tube

General: Double 60^{o} deflection, 5 cm radius of curvature with Alinco VI magnets mounted external to the vacuum system. Flanged, self-aligning ion source and collector assemblies allow easy maintenance.

a. Ion Gun:

Exclusive constant sensitivity, self-cleaning, heat repeller type.

b. Filament Assembly:

Tungsten ribbon, non-warping, screw-mounted, self-aligning.

c. Ion Collector:

Consists of an ion target and complete preamplifier stage mounted within the vacuum.

2. Scan Control:

Front panel mounted helium scan control assures positive helium identification by detuning ion accelerating voltage plus and minus 10% from helium peak.

3. Mechanical Pumps:

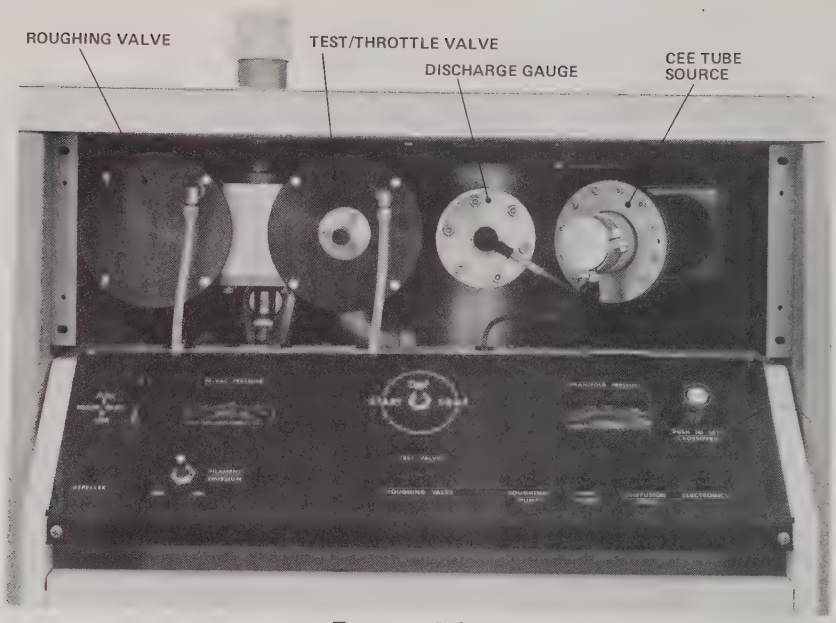
Roughing pump capacity is 5.6 cfm (10.6 cfm pump optional), driven by 1/2 H.P. motor; forepump capacity is 0.9 cfm, driven by a 1/3 H.P. motor.

4. Diffusion Pump:

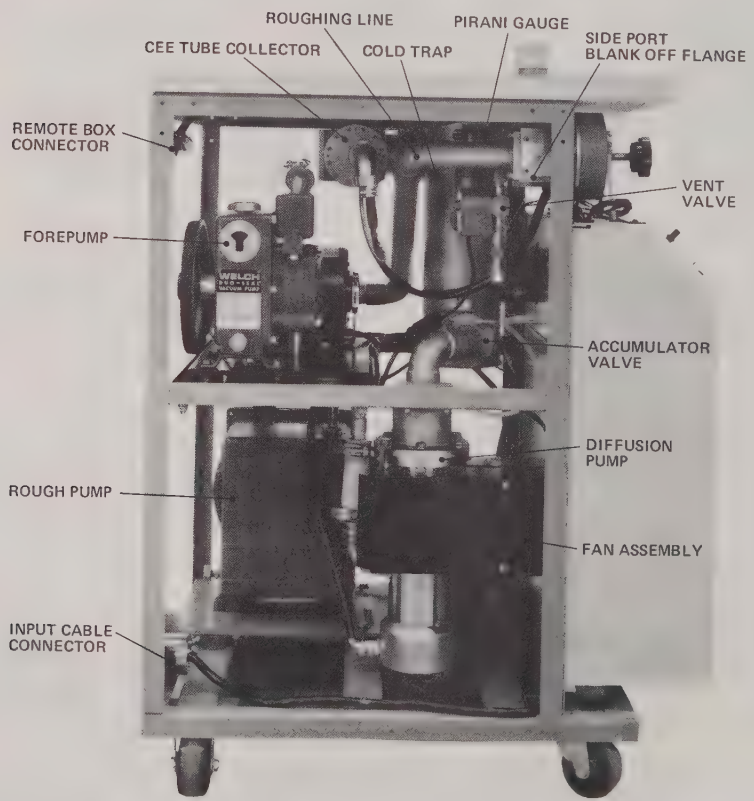
Low pressure and rapid helium clean-up provided by air-cooled four stage Veeco EP3AB.

5. Cold Trap:

Low-loss "Isotherm" design maintains all surfaces at same temperature even as refrigerant level falls off. Liquid nitrogen is the recommended refrigerant. Consumption is 0.8 liters per 8-hour day, neglecting transfer losses. Fills from top work surface. Flanged and accessible from top work surface for easy removal.



Front View



Left Side View

Figure 2. Major Vacuum Components

6. Valves:

Accumulator valve, between cold trap and diffusion pump, is a 1 1/4" butterfly valve, manually operated. Handle is behind door in sub-panel. Rough and test valves are bellows sealed, electrically actuated, pneumatically operated. Vent valve is disc-seal type and solenoid operated.

7. Maximum Operating Pressure:

3×10^{-4} torr.

8. Housing:

Bench console 22 1/4" wide, 28 1/8" deep, 36 1/8" high (see Figure 3)

9. Vacuum Gauges

a. Cold Cathode Discharge type:

Aluminum body with externally mounted magnets. Anode is flanged for ease of maintenance. Useful range is between 10^{-6} torr and 5×10^{-4} torr. Monitors high vacuum section, provides trigger for filament protection circuit.

b. Pirani Gauge:

Threaded to roughing line, monitors test chamber pressure and its associated controller, directs the AUTOmatic cycle. Useful range is over 1 torr to 10^{-3} torr.

10. Safety Interlocks:

The unit will not cycle in the AUTOmatic mode unless the filament is operating.

The output of discharge gauge actuates a relay which automatically shuts off filament power when pressure rises above safe operating range.

11. Calibration:

Calibration is accomplished by means of a helium leak and is in direct readout for air.

12. Power Requirements:

System requires 15 Amps at 115 Volts, with 5.6 cfm pump; 17 Amps with 10.6 cfm pump. 50 or 60 Hz as specified.

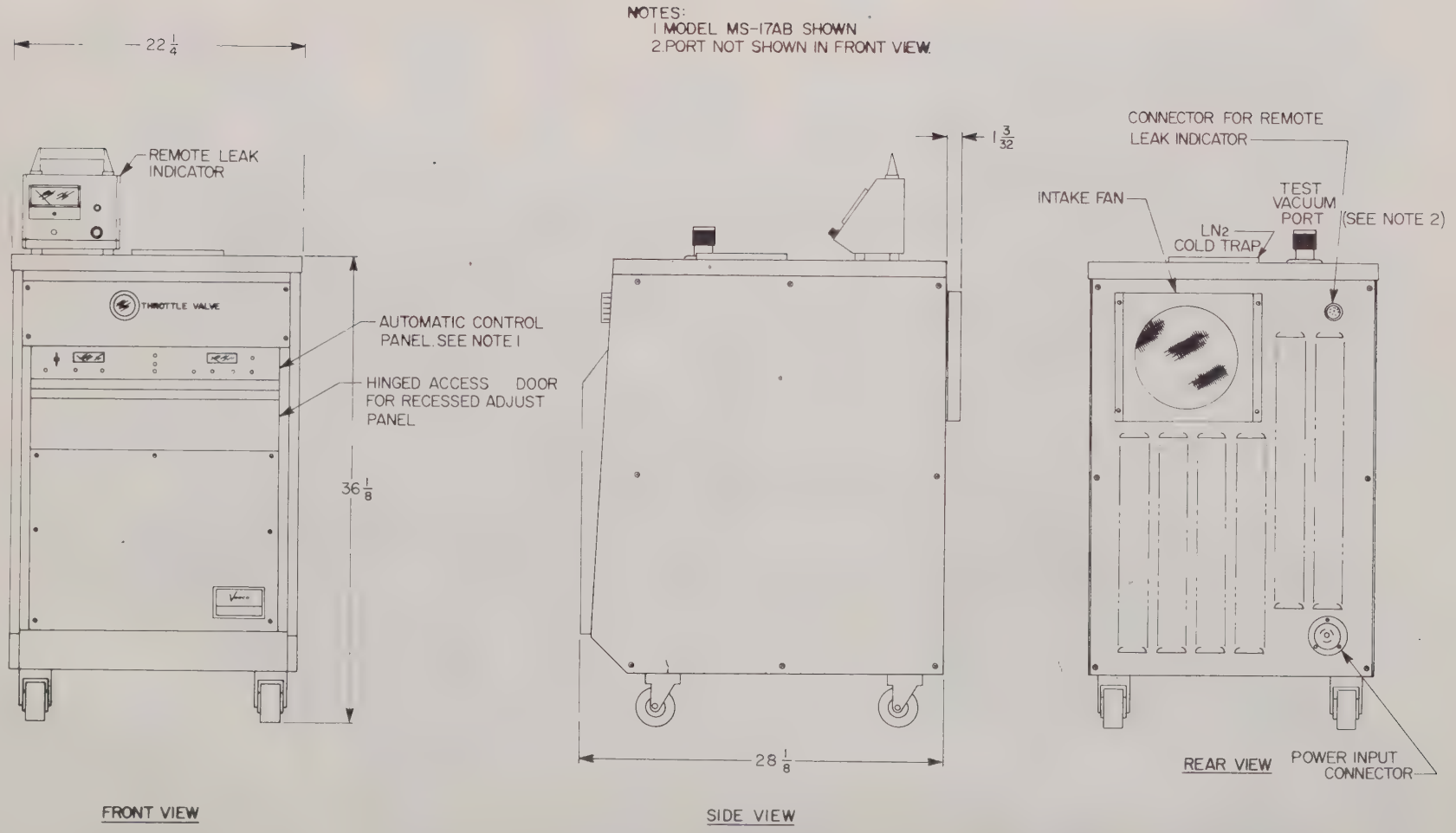


Figure 3. MS-17 Dimensions

13. Accessories:

The following accessories are included:

a. Operation and Maintenance manuals (2)

b. Spare filaments (5)

c. Tool Kit

d. Liquid Nitrogen funnel

e. Wall receptacle (for power cord)

f. Mechanical Pump oil (1 qt.)

g. Filter Cote (1 pint)

NOTE

A recommended accessory, not included with the unit is the Veeco flameless heat degassing gun (Part No. 4330-000).

B. THEORY OF OPERATION (See Figure 4)

1. "Cee Tube" Mass Spectrometer Tube

The MS-17 series leak detectors offer the user the advantages of consistently high sensitivity and excellent rejection of spurious background signals. These advantages result from the unique design of the system's split sector spectrometer tube. Ordinarily a leak detector's sensitivity will be severely impaired when large amounts of other gases are present. This is due to the spurious background reading produced by these gases which will obscure a small helium signal. The MS-17 Cee tube eliminates this background and enables the user to realize the full sensitivity of the instrument under a wide range of circumstances. (In addition, the MS-17 has improved protection devices, modular electronics and vacuum system for enhanced versatility and easier maintenance).

The Cee tube, a split sector tube, is a special mass spectrometer that is designed specifically to detect the presence of extremely small quantities of helium gas. The arrangement is such that this can be done even when relatively large quantities of other gases are present in the tube. See Figures 5 and 6.

The spectrometer tube is the main functional unit of the leak detector, the other components of the system serve in the auxiliary capacities of providing a proper operating environment within the tube and measuring its output. Since the interior of the tube must be maintained under high vacuum, a complete vacuum system - consisting of pumps, gauges, valves, and trap - is provided; these will be described in succeeding paragraphs.

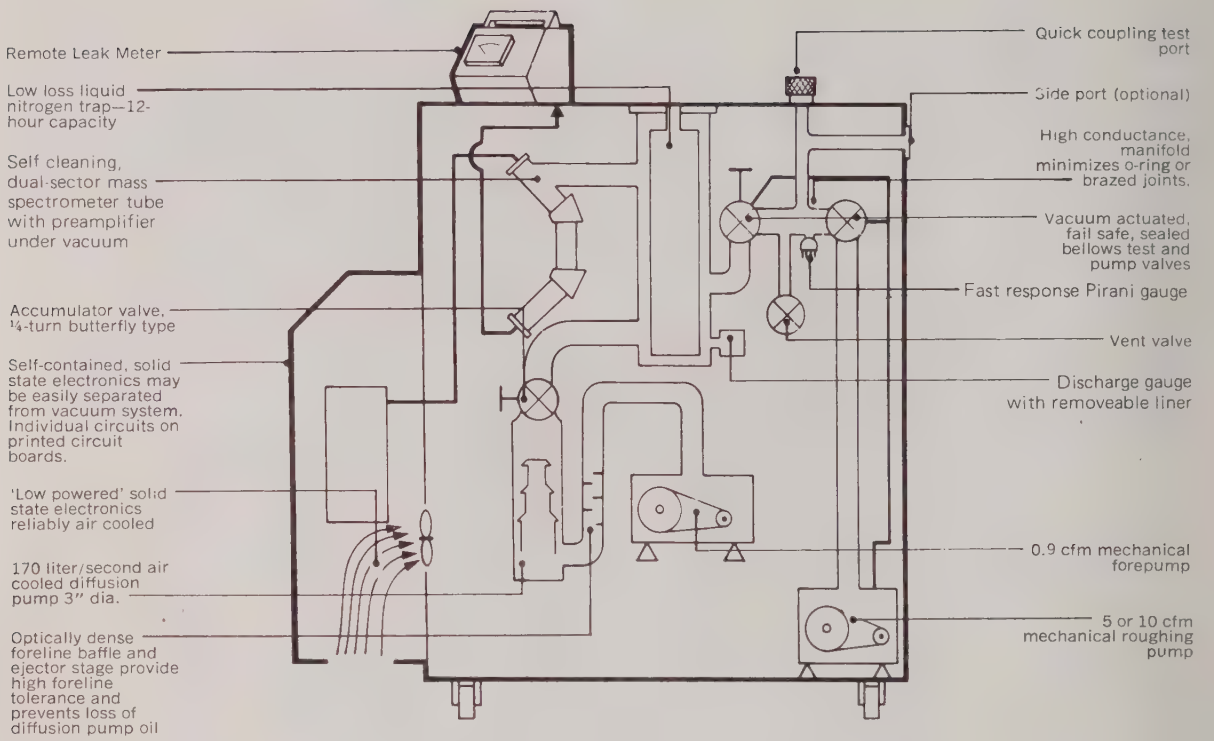
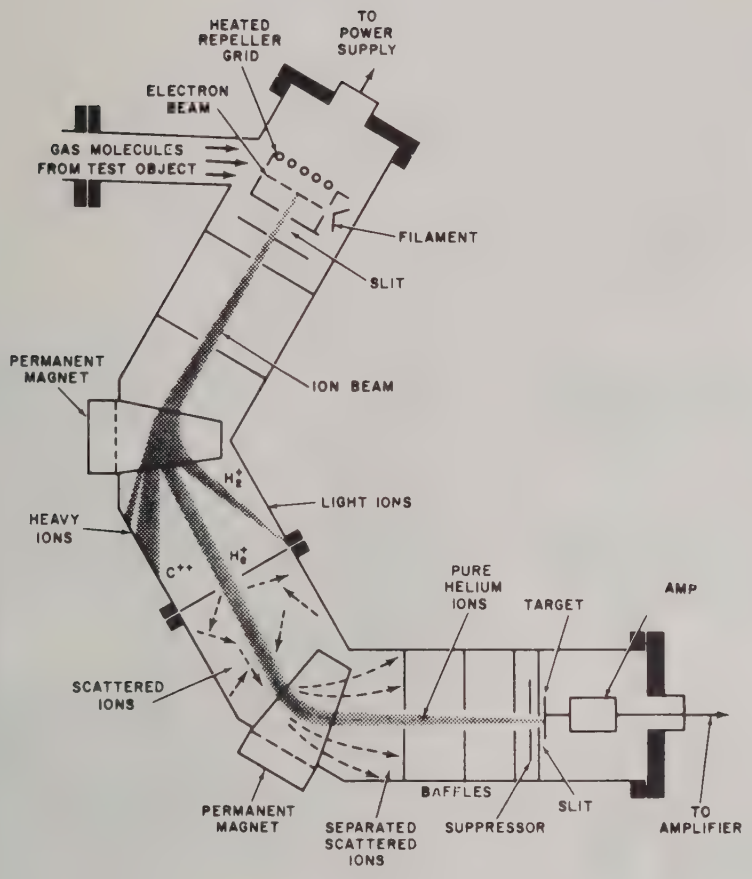

Remote Leak Meter
Low loss liquid nitrogen trap—12-hour capacity
Self cleaning, dual-sector mass spectrometer tube with preamplifier under vacuum
Accumulator valve, ¼-turn butterfly type
Self-contained, solid state electronics may be easily separated from vacuum system. Individual circuits on printed circuit boards.
'Low powered' solid state electronics reliably air cooled
170 liter/second air cooled diffusion pump 3" dia.
Optically dense foreline baffle and ejector stage provide high foreline tolerance and prevents loss of diffusion pump oil
Quick coupling test port
Side port (optional)
High conductance, manifold minimizes o-ring or brazed joints.
Vacuum actuated, fail safe, sealed bellows test and pump valves
Fast response Pirani gauge
Vent valve
Discharge gauge with removeable liner
0.9 cfm mechanical forepump
5 or 10 cfm mechanical roughing pump

Figure 4. MS-17AB Vacuum Schematic

The operation of the spectrometer tube is divided into three functions: ion production, separation, and ion collection. These three operations are closely integrated to serve the purpose of detecting minute quantities of helium. A general description of the working principles behind these functions follows:

a. Ion Production

Since neutral atoms and molecules of gas cannot be separated by a magnetic mass spectrometer, they must first be converted to positively charged ions. This is accomplished by the ion source. Inside the ion source there is a tungsten filament which is heated by passing an electric current through it. (The source is provided with two separate filaments; should one burn out, the other can be activated simply by actuating a switch on the sub-panel.) The hot filament emits a regulated beam of electrons, when these electrons collide with the atoms and molecules of gas they "knock off" electrons, thus producing the positive ions. Upon formation, these ions encounter the electrostatic fields established within the ion source by the ion repeller, the ion chamber, the focusing plates, and the object plate. The effect of this arrangement is to accelerate the ions in a well-defined, mono-energetic beam.



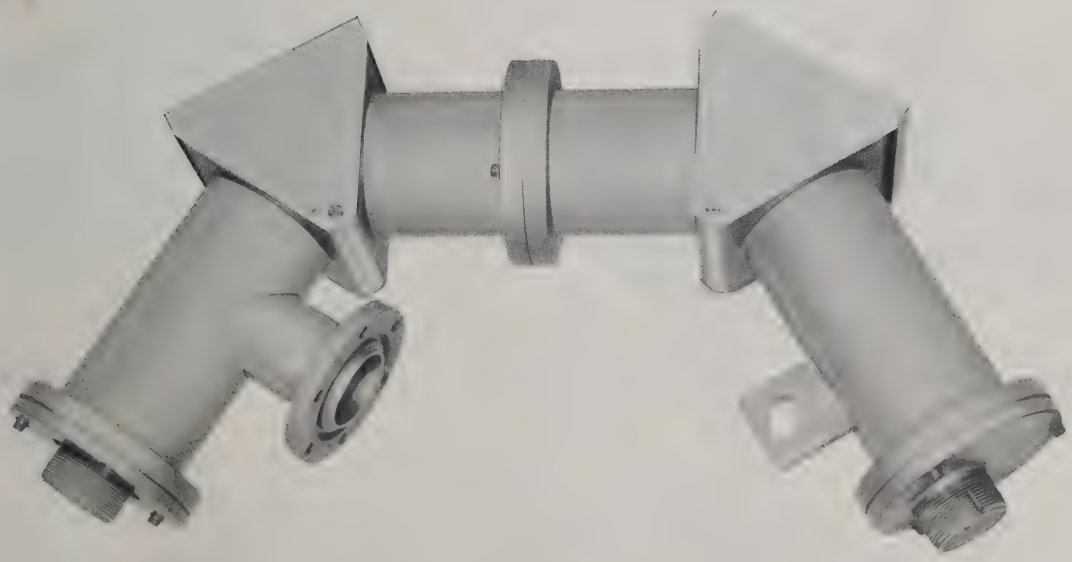
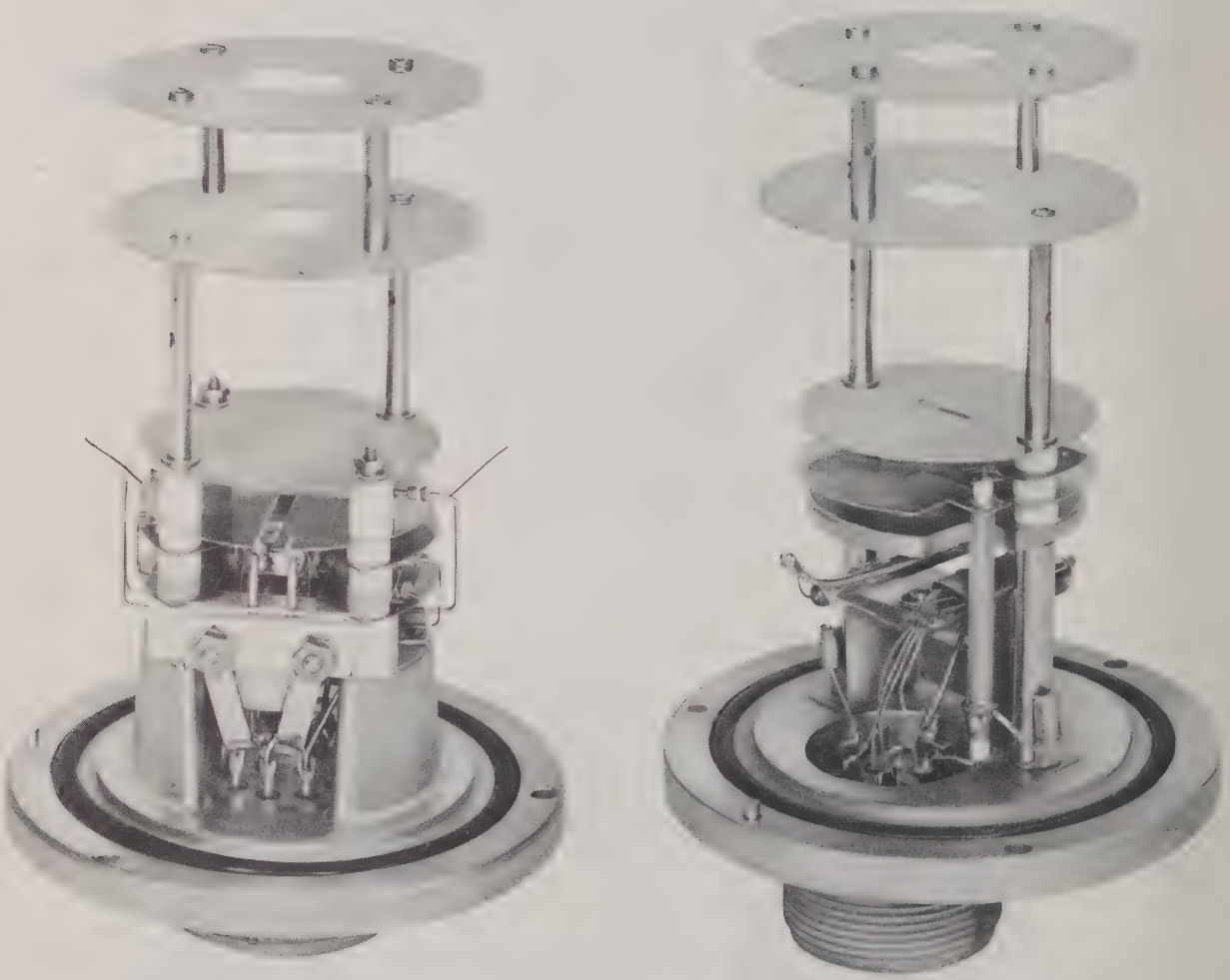


Figure 5. Split Sector Mass Spectrometer Tube (Cee Tube)



Source

Collector

Figure 6. "Cee Tube" Source And Collector Assemblies

b. Ion Separation

Since the gas entering the spectrometer tube contains atoms and molecules of different kinds, the ion beam will likewise contain a variety of ions such as nitrogen, oxygen, carbon dioxide, and, if a leak is found, helium. The magnetic field separates the helium ions from the remainder of the ion beam, and deflects these ions on to the detector. Two Alnico VI magnets are mounted outside the vacuum system and set up magnetic fields perpendicular to the ion beam. These magnetic fields cause the ions to be deflected, with the deflection dependent upon the mass of the ion (lighter ions such as hydrogen will be deflected more than heavier ions such as oxygen). In the first magnet, the arrangement is such that only helium has the right mass to pass through the magnetic sector and through the opening in the baffle on the other side; most of the other ions will be deflected too much or too little and, therefore, will be intercepted by the baffle between the two magnets. However, because of scattering and bounce within the tube, some of the non-helium ions may still get past the baffle. To eliminate these ions a second magnetic field identical to the first again deflects the charged ions through a second baffle. By means of this exclusive Veeco arrangement of magnets and baffles, helium is selectively transmitted to the targets, while other gases,- which may be present in large amounts,- are rejected.

c. Ion Collection

The helium ions, having travelled the length of the tube, must pass through a series of baffles and a slit-plate which further defines the beam. Located behind this "slit" is a metal plate called the "target". As an arriving helium ion strikes, the target becomes positively charged, an electron then flows through the grid resistor towards the charge of the ion. The flow of these electrons constitutes a minute current, on the order of 10^{-15} Amperes. The current flow is detected and amplified by an electrometer tube located within the Cee tube. (Mounting this first stage of amplification in the high vacuum environment assures stability, minimizes the time constant and reduces stray "noise" pick up.) The electrometer is connected to an external amplifier and the resultant amplified signal, which is proportional to the amount of helium in the Cee tube, appears as a visual indication on the leak indicator meter.

2. Vacuum System

As mentioned previously, the spectrometer tube operates in a high vacuum. Therefore, a complete, self-contained vacuum system is provided, consisting of the components described in the following paragraphs:

a. Vacuum Pumps

(1) Mechanical Pump: The mechanical pump offers the fastest and simplest means of removing large quantities of gas from a vacuum system. The pump operates by means of an eccentrically-mounted, oil-sealed rotor, which is turned by an electric motor. As the rotor

turns, it compresses the gases from the system into a smaller volume, increasing their pressure until they intermittently force open an oil seal valve and escape into the atmosphere. Such pumps are capable of reducing the system pressure to less than 1 millitorr (micron). The pump has two stages in series (see Figure 7).

(2) Diffusion Pump: The lowest pressure attained by the mechanical pump is not low enough for operation of the spectrometer tube. In order to attain a sufficiently low pressure, an oil diffusion pump is employed (see Figure 8). Heating the reservoir of oil in the base of the pump produces an upward flow of vapor through the center of the pump. The jets deflect the oil vapor outward and downward toward the outside wall, which is air cooled. Striking the cool wall, the oil vapor condenses then flows back down to the reservoir, where it is re-evaporated. Pumping action is achieved when the molecules of gaseous constituents within the vacuum system are trapped in the outward and downward stream of oil vapor and forced lower and lower by each of the three succeeding jets. The 4th stage is an ejector jet which compresses the molecules into the foreline to be removed by the forepump. This stage also cuts down drastically the contamination of the diffusion pump oil by back migration of the mechanical pump oil. The use of an ejector stage also increases the compression factor of the pump considerably, thus preventing helium molecules from getting back past the upper jets.

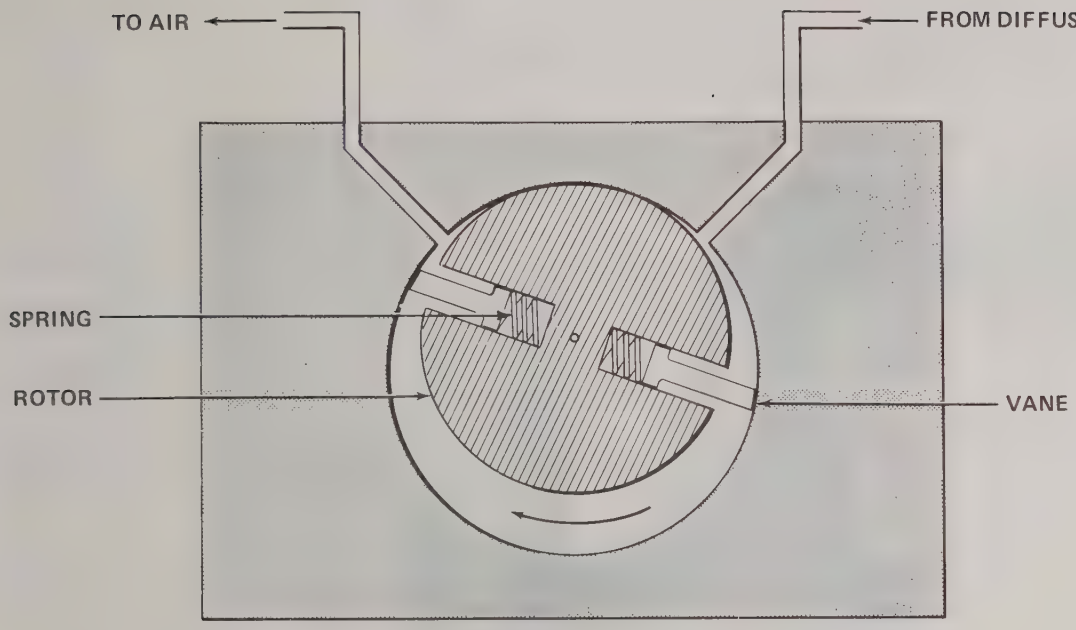
The diffusion pump used in the MS-17 series utilizes a four stage fractionating pump stack. The fractionating section in the boiler compartment combined with the ejector stage insures continuous purification of diffusion pump oil. This self-purifying action results in satisfactory performance despite poor diffusion pump oil condition and/or system contamination.

An oil diffusion pump can neither pump on nor exhaust to atmospheric pressure; moreover, the pump oil (Octoil) will decompose and oxidize if exposed to atmosphere at operating temperature. Therefore, a mechanical pump (known as the forepump) operates in series with the diffusion pump. The forepump creates a vacuum at the base of the diffusion pump causing gas molecules pumped by the diffusion pump to exhaust to atmosphere.

In the MS-17AB version another mechanical pump (known as the roughing pump) evacuates the chamber to the point at which its volume can be exposed to the high vacuum section without critically raising the pressure in the high vacuum section of the system.

b. Cold Trap

The function of a cold trap in a vacuum system is to freeze out the residual condensible vapors and is the third type of pump used in the system. This freezing is accomplished by providing highly refrigerated surfaces upon which the vapors are trapped. The most common vapors encountered are oil vapor from diffusion and mechanical pumps, and water vapor (see Figure 9).



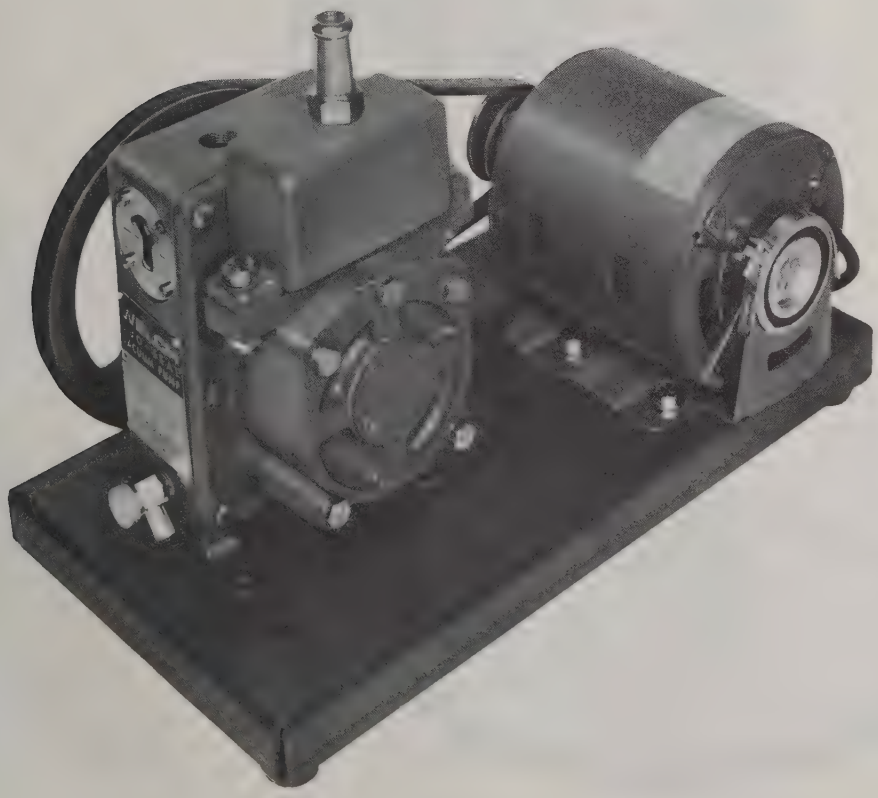


Figure 7. Mechanical Pump

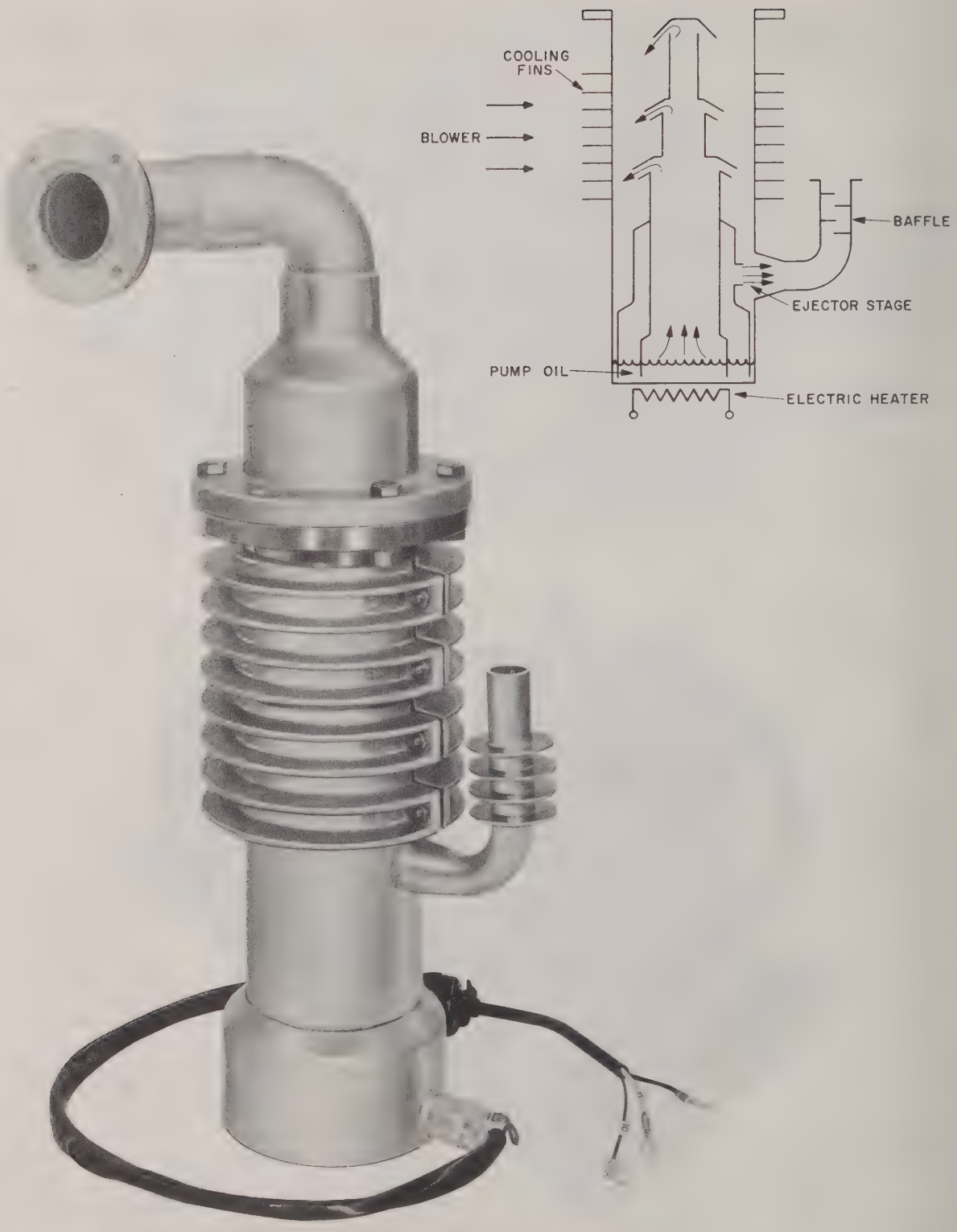


Figure 8. Diffusion Pump

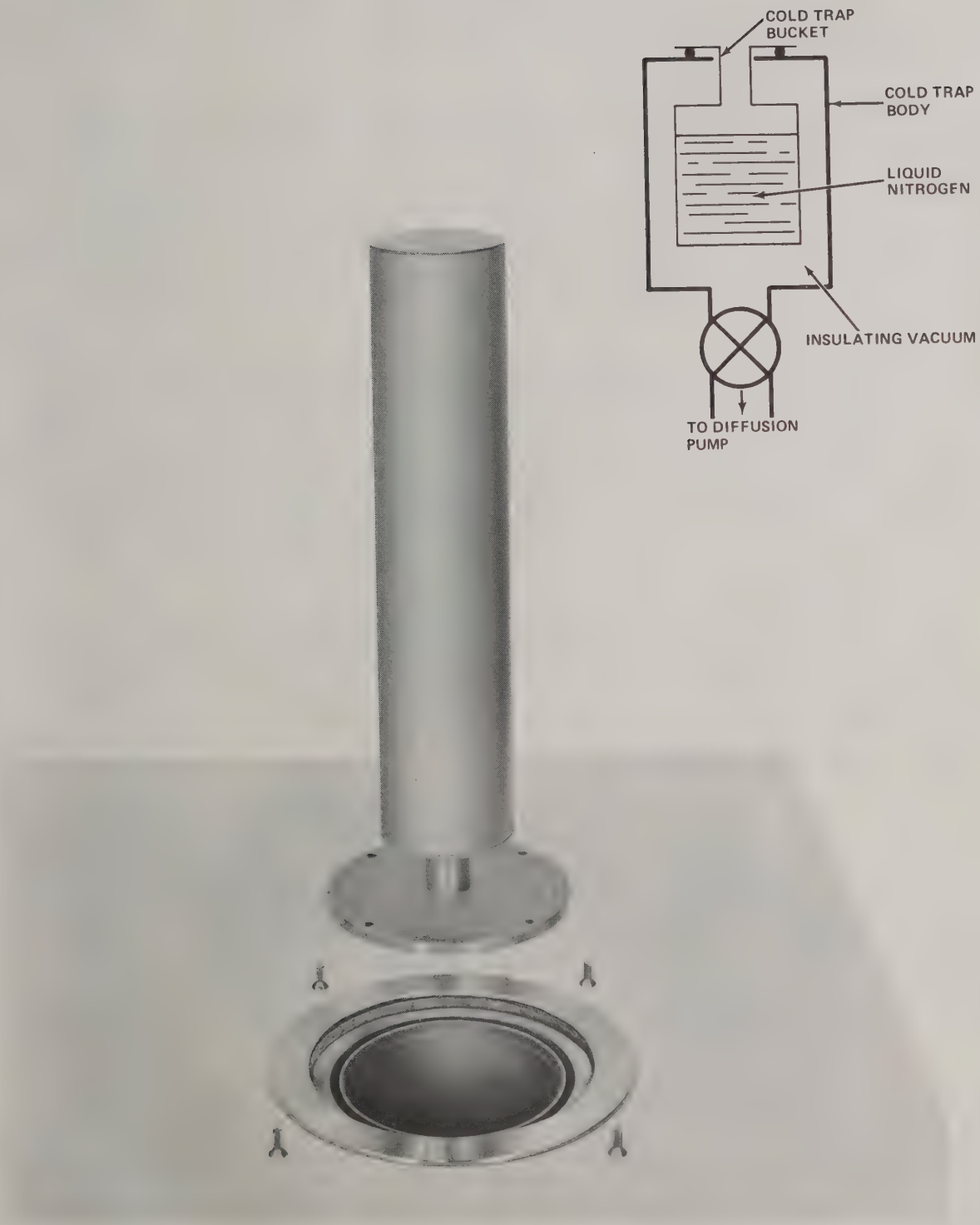


Figure 9. Cold Trap

The cold trap of the MS-17, when refrigerated with liquid nitrogen, acts as a highly efficient pump for condensibles such as water vapor, and therefore, reduces pump down times by as much as a factor of ten or more.

(1) Refrigerants: The lower the temperature of the coolant, the more effective the trap. The recommended coolant for the Veeco MS-17 leak detector is liquid nitrogen. Liquid air is almost equally effective, but somewhat more dangerous, since the liquid oxygen in it may constitute a fire hazard. The use of dry ice and acetone mixtures is not recommended, because the temperature is not low enough for effective trapping. The vapor pressure of water at dry ice temperature is above 1 micron. If liquid nitrogen is not available, it is usually better to operate with no coolant whatsoever.

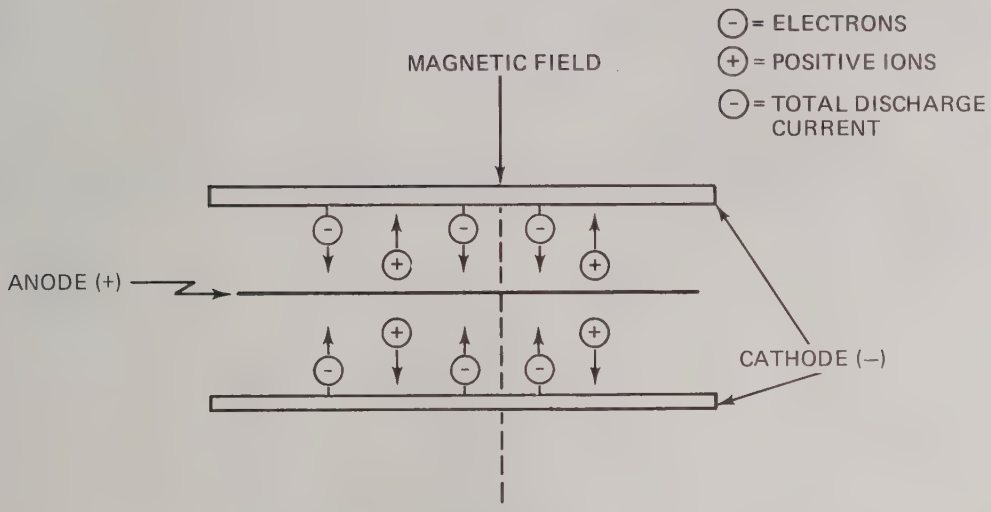
(2) Construction: The construction of the cold trap is similar to a thermos bottle; that is, it consists of an inner and outer shell, insulation being provided by the vacuum in between. In operation, the inner low-loss stainless steel refrigerant bucket is filled with liquid nitrogen. The filling port is located on the top work surface. The trap can be completely filled up with the liquid nitrogen contained in a Veeco 2 liter dewar. In order to minimize transfer losses, the use of the dewar (P/N 1990-693) is highly recommended.

c. Vacuum Gauges

At various points throughout the operating cycle of the MS-17, pressure in different sections of the leak detector might vary in different directions. In order to provide an indication of pressure and permit automatic control, vacuum gauges are used to detect pressure levels and produce a corresponding electrical signal. In the MS-17, there are two gauges operating by different principles over different pressure ranges.

(1) Cold-Cathode Discharge Gauge: This type of gauge consists of two electrodes mounted inside the vacuum. External to the vacuum system is a permanent magnet which establishes a magnetic field threading the loop of the anode (see Figure 10). When high voltage is applied across the electrodes, a discharge results. The current passing through the discharge is proportional to the pressure and read out on a meter calibrated in pressure units. The useful range of the discharge gauge is between 1×10^{-7} and 5×10^{-4} torr, and is used to monitor the pressure in the high vacuum section of the leak detector and to trigger the filament protection circuit.

However, above 100 torr, the discharge gauge behaves as if the system pressure were much lower, and would re-energize the filament at high pressure. To avoid this, a spark gap is placed in parallel with the discharge gauge and simulates a pressure reading of 100 torr; this provides protection over the entire range from 3×10^{-4} torr to atmosphere. Not withstanding these protective devices, care must be exercised not to expose the filament to repeated bursts of high pressure. Otherwise, its life may be shortened. With reasonably careful operation, the filament will provide several thousand hours of service.



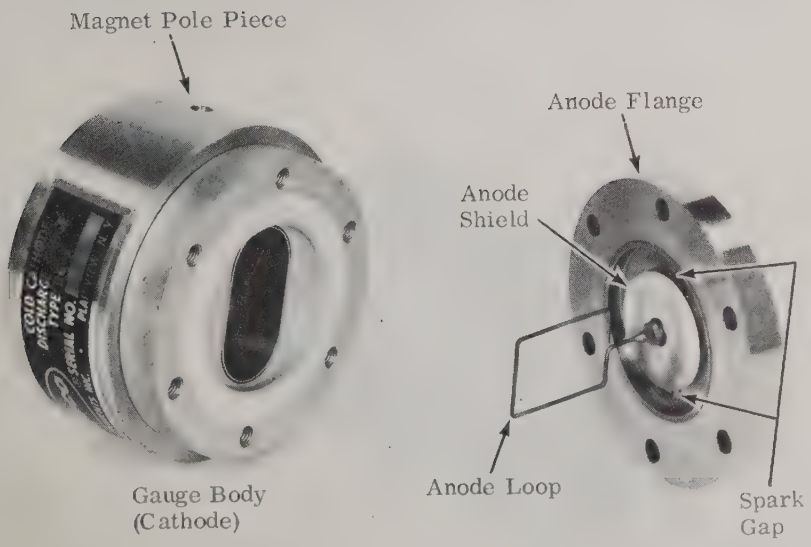


Figure 10. Cold Cathode Discharge Gauge

(2) Pirani Gauge: This type of gauge consists of a resistive element mounted inside the vacuum. The presence of molecules in the vacuum chamber is in direct proportion to the pressure. These molecules act as a heat sink for the Pirani gauge's resistive element, which is being driven by a constant current generator (see Figure 11). The varying voltage across the Pirani gauge's resistive element is amplified and provides an indication of vacuum chamber pressure via a meter. This gauge is situated in the test manifold and, during an automatic roughing cycle, determines if pressure has been sufficiently reduced to allow exposure of the test manifold to the high vacuum section (see Figure 2).

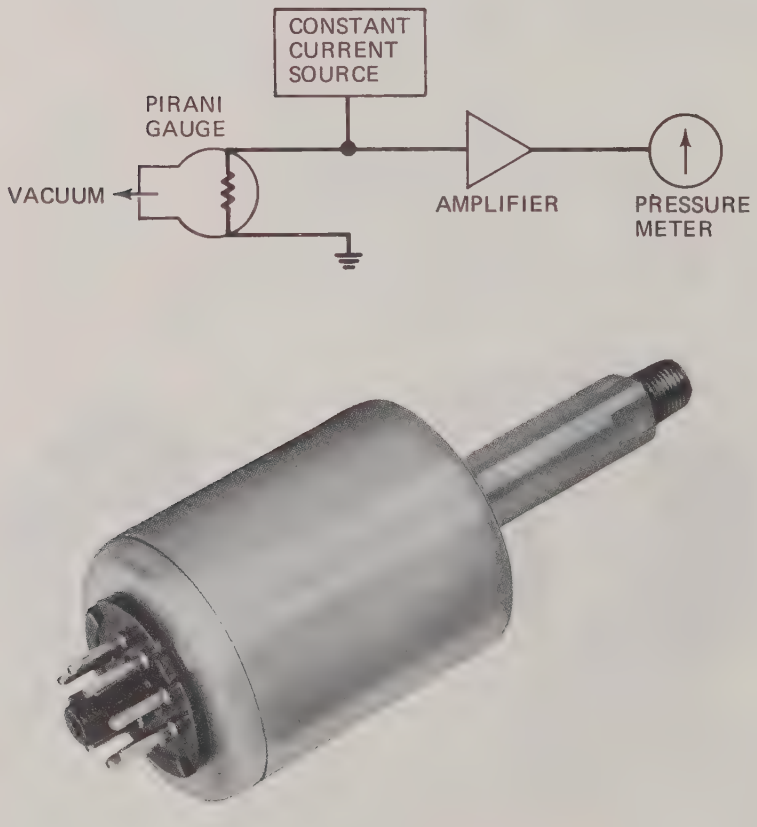


Figure 11. Pirani Gauge

d. Valves

(1) High Vacuum Valves: Under certain circumstances, it is necessary to isolate, either completely or partially, sections of the leak detector from one another. This function is served by two valves designed especially for high vacuum service. These valves are common to the MS-17A, AB and ABC.

(a) Accumulator Valve: This valve, located between the cold trap and the diffusion pump, serves to isolate the diffusion pump and fore pump from the rest of the vacuum system. The control knob is readily accessible at the convenient service panel. Under ordinary leak test conditions, the valve is completely open, but it can be closed for such maintenance operations as cleaning the refrigerant bucket or servicing the spectrometer tube ion source. This isolates the diffusion pump in order to gain access to the cold trap and spectrometer tube The user may also employ accumulation techniques, by partially closing the accumulator valve. thereby decreasing pumping speed and making possible the detection of smaller leaks. This valve is a quarter-turn butterfly valve, linked to a knob in the service panel by a simple, push-pull rod.

(b) Throttle Valve: This is the most important valve in the MS-17 leak detector since it controls the rate of gas flowing into the leak detector from the system being tested. This valve has been especially designed for throttling service. When testing for relatively large leaks, it is often necessary to throttle from a test system pressure of several hundred microns down to a Leak Detector pressure of a few tenths of a micron. The throttle valve is a manual override of the test valve and when leak testing in AUTOMATIC it is always left in the full open position. It is normally only used in MANUAL mode.

3. Electronics

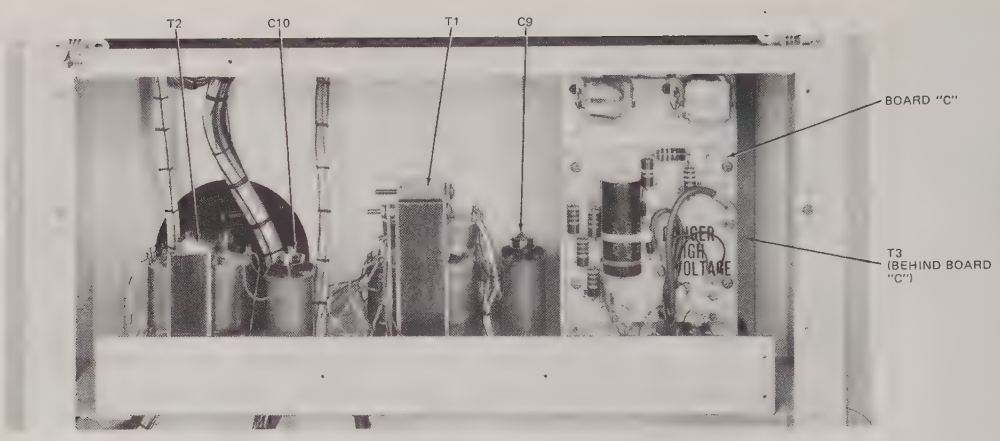
a. General (see Figure 12)

All electronic circuits are contained in the front electronic cabinet and in the leak indicator. Most of the electronic components are on circuit boards (boards A, B, C and E). Three of the printed boards (A, B and E) are of the plug-in type, board C is hard-wired due to high voltage considerations.

b. Electronics of the MS-17A

(1) Board "A"

(a) Repeller Heater Supply: In the MS-17, the ion source is continuously baked by means of a patented ion-source heater operating at temperatures in excess of 900°C. This continuous high capacity heating keeps the entire source clean at all times. The temperature and amount of heat generated prevent vapors from condensing, and drive off any vapors condensed during the brief periods it is not operating. The circuit receives power whenever the diffusion pump circuit breaker is on. As a result of this self-cleaning action, it is not necessary to keep the cold trap filled except during periods of leak testing.



Board A, B and C Mounting Panel Lowered

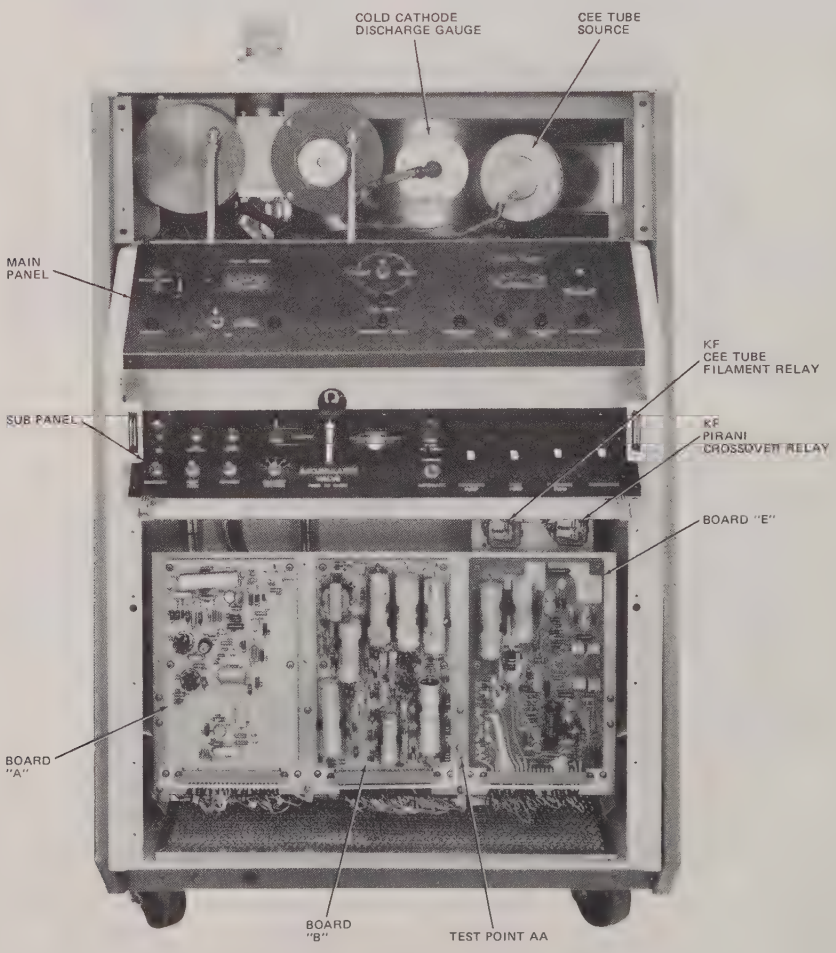


Figure 12. MS-17AB Electronics, Front View

The repeller heater supply has an indicator light, on the left side of the control panel, to indicate when the repeller grid is receiving power.

(b) Cee Tube Source Power Supply: Provides regulated voltages for the various electrodes in the Cee tube's ion source, such as the ion repeller, electron focus and the ion focus. It also supplies the accelerating voltage to the ions which are formed. The above voltages are controlled from the sub panel, located below the main panel. Once these controls are adjusted for maximum helium output, they should not be touched except when direct readout cannot be obtained by means of the calibration potentiometer. The emission current can be read on the meter when the FILAMENT-PRESSURE-EMISSION knob is turned and held at EMISSION.

(c) Filament Protective Circuit. The output of the discharge gauge, through driving transistors, de-actuates a relay which automatically shuts off the filament power when pressures exceed the safe operating range.

(2) Board "B"

(a) Helium Amplifier Power Supply: This supplies regulated DC voltages to the helium amplifier (the electrometer). It consists of a winding from a constant voltage transformer and an integrated circuit voltage regulator with an ultra-stable reference (see Figure 13).

(b) Helium Amplifier: The helium amplifier, (the electrometer), is a four-stage direct-coupled, degenerative feedback type. The first stage of which is located within the Cee tube. The amplifier output is read on the Leak Indicator (see Figure 14).

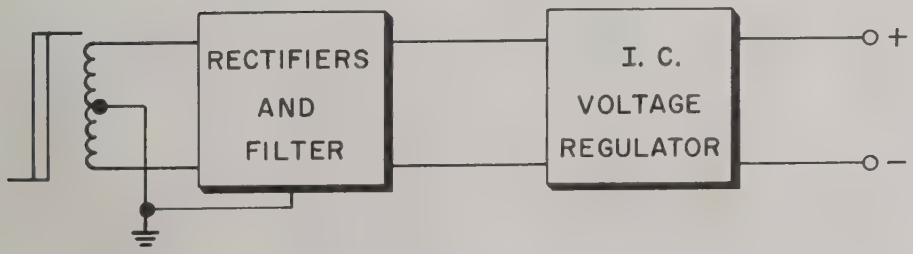


Figure 13. Helium Amplifier Power Supply, Block Diagram

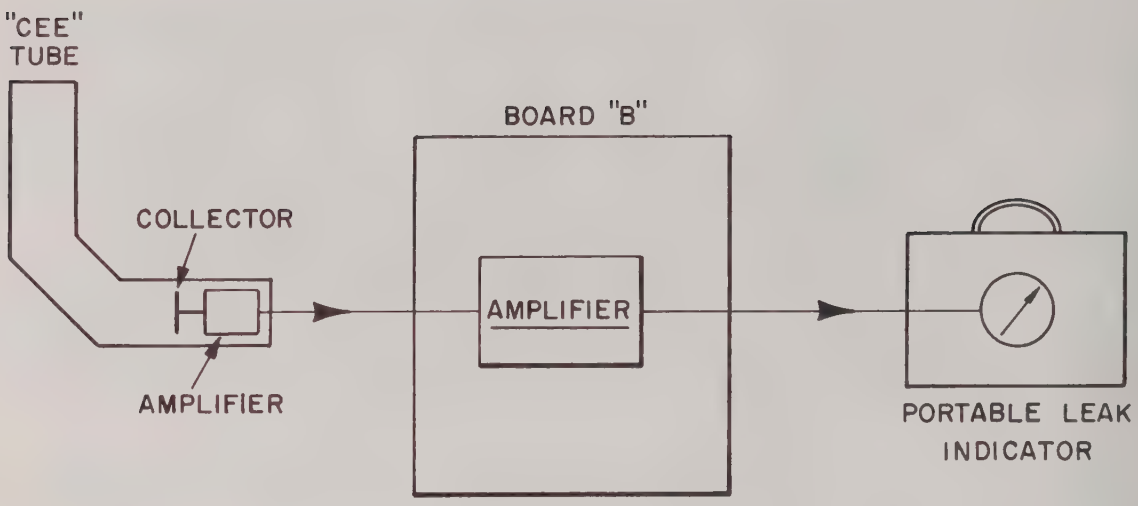


Figure 14. Helium Amplifier, Block Diagram

(c) Zero Offset Power Supply: This is a completely isolated power supply. It consists of a winding from a constant voltage transformer, floating on both sides, and an I.C. voltage regulator. Its output is fed to the Leak Indicator as shown, (see Figure 15).

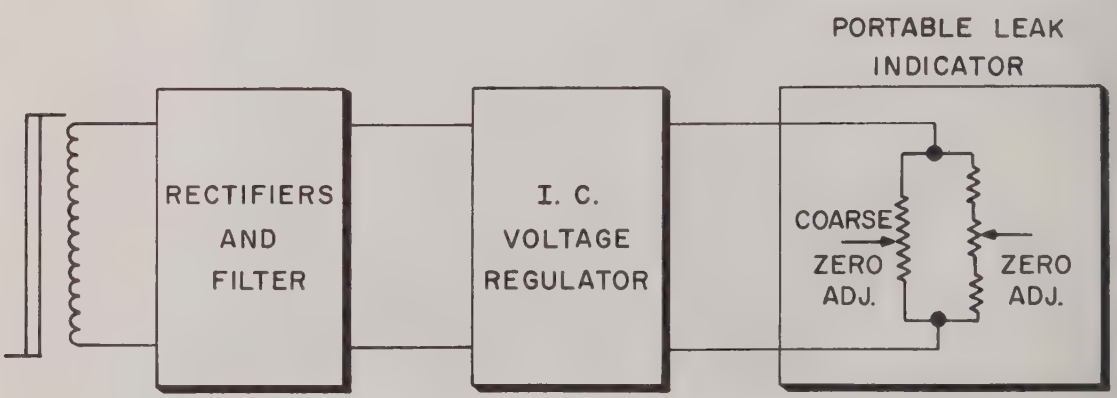


Figure 15. Zero Offset Power Supply, Block Diagram

(3) Board "C"

This board contains the high voltage rectifier, filter, and resistive network for the cold cathode discharge gauge.

(4) Electronic Controls and Leak Indicator

The controls and indicators can be divided into three parts on the MS-17, the main panel, the sub panel and the portable leak indicator.

(a) Main Panel (See Figure 16): The main panel (the top front panel) contains the combination HI VAC PRESSURE meter on the left, FILAMENT ON-OFF switch, FILAMENT EMISSION lamp, REPELLER HEATER lamp, and the helium SCAN switch which detunes the ion accelerating voltage plus or minus 30 Volts from the helium peak to assure positive helium identification.

(b) Sub Panel (See Figure 16): The sub panel contains circuit breakers and indicators lamps for the forepump, diffusion pump and electronics; the filament-pressure-emission switch, the dual filament selector switch, the filament voltage selector switch and the tuning controls. The filament voltage may be varied by the filament voltage switch, which connects one end of the supply to different taps on the transformer.

(c) Dual Filament Selector Switch: The MS-17 series leak detectors are equipped with dual filaments in the spectrometer tube source. One leg of each filament is common and the other leg is connected to the filament power supply through a switch. The switch for selecting which of the two filaments is to be in operation is located on the sub panel. The filament selector switch may be placed in either position. Should one filament burn out, simply switch to the other filament, retune, and continue leak test operations.

(d) Portable Leak Indicator (See Figure 17): The portable leak indicator contains the leak indicator meter (which indicates the output of the helium amplifier), a full scale switch with seven ranges, test indicator lamp and the zero adjust control. In the rear are the COARSE ZERO ADJUST, CALIBRATE control and the output jack for the recorder. Available as an option is a Portable Leak Indicator providing an audio tone, in addition to a meter indication to indicate a leak.

c. Electronics of the MS-17AB

For the MS-17AB, plug-in board "E" is added to circuit boards "A", "B" and "C". It contains a D.C. power supply for the valves, Pirani amplifier, driver and a relay circuit. The MAINFOLD PRESSURE meter is located in the right side of the main panel. Test valve and roughing valve pilot lamps are beneath the START-OFF-VENT switch. A PUSH-TO-SET CROSS-OVER switch is located at the top corner

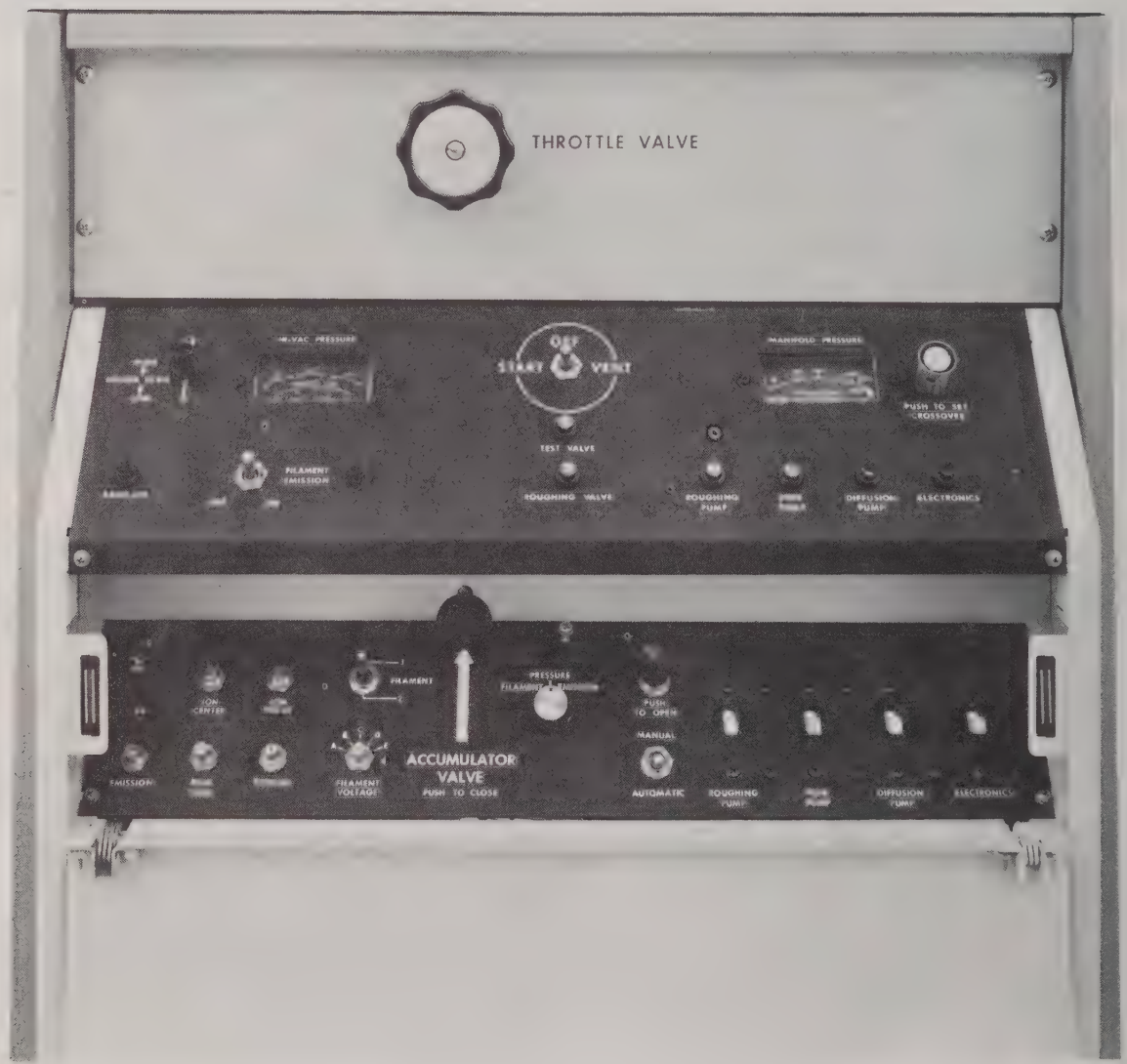


Figure 16. Main And Sub Panels

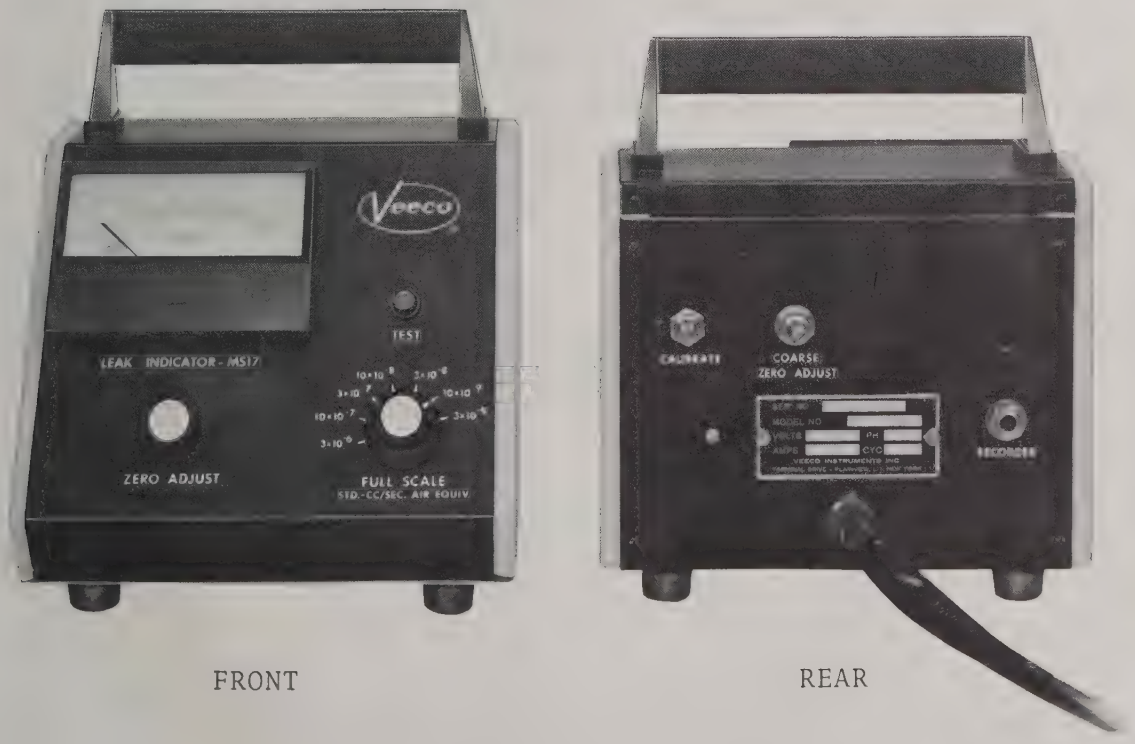
of the main panel. Normally the crossover is set at approximately 20 millitorr, to limit the crossover burst, shown on the HI-VAC PRESSURE meter, to 1 x 10^{-4} torr. A circuit breaker for the roughing pump is located on the sub panel.

(1) Pirani Controller: The Pirani controller prevents the test valve from opening until the vacuum reaches a preset value. The control point is adjusted by the CROSS-OVER control knob, located at the extreme right of main panel. It is monitored on the MANIFOLD PRESSURE meter located on the main panel, by pushing down the CROSS-OVER knob.

The MANIFOLD PRESSURE control is operative only when the mode switch is in the AUTOMATIC position.

NOTE

Vent valve has a time delay of 1 or 2 seconds.



FRONT REAR

Figure 17. MS-17AB Portable Leak Indicator

Section III

OPERATION

A. INSTALLATION OF MS-17 SERIES LEAK DETECTORS

1. Uncrating

(These instructions are also stapled to the side of the shipping crate refer to Figure 18).

NOTE

Remove the unit from the shipping case with care. If any visible damage has occurred, file claim with the carrier immediately; they are responsible. Do not repack and return such units. As soon as any visible damage is noted, immediately stop unpacking and call shipping agent (see bill of lading). Always save the shipping container, as is, for carrier inspection.

a. Remove steel straps from cardboard crate

b. Lift crate straight up

c. Roll unit off skid (base of crate)

2. Connections

The oil diffusion pump and mechanical pumps are shipped with oil in them. Before operation of equipment, shipping plugs and Tie Down Straps (or Bolts) must be removed, rubber hose foreline connection must be made, and exhaust baffles must be screwed in place on the mechanical pumps.

3. Circuit Breakers

Make sure all circuit breakers are OFF before connecting power; then follow step-by-step procedures for the particular model you have.

4. Power Requirements

The MS-17 series operates on 115 Volt, 60 Hz current. The units are supplied with a power cable plug which has a separate ground prong (the female receptacle is also supplied and shipped with the units). A GOOD GROUND is important for both safety and good operation.

PACKING MATERIALS

1. Tri-Wall Container
2. Accessory Containers
3. Top Grid
4. Leak Detector
5. Power Line Cord
6. Corner Blocks (4)
7. Wooden Base Skid

TO UNPACK

1. Inspect for possible damage first.
2. Remove steel strapping and lift container straight up.
3. Remove accessory containers, top grids and four corner blocks at base of skid. The power line cord will be found in the left front corner block.
4. Detach 2 x 3 block from skid for freedom of fork lift when available.

CONTENTS OF ACCESSORY CONTAINERS

#1 contains the accessory kit-consiting of:
1 -Qt. oil (1990-001)
1 -Receptacle (1950-014)
1 -Funnel (1330-129)
1 -Box Filaments (0103-141-01)
1 -Tool Kit (0126-185)

#2 contains:
1 -Leak Indicator

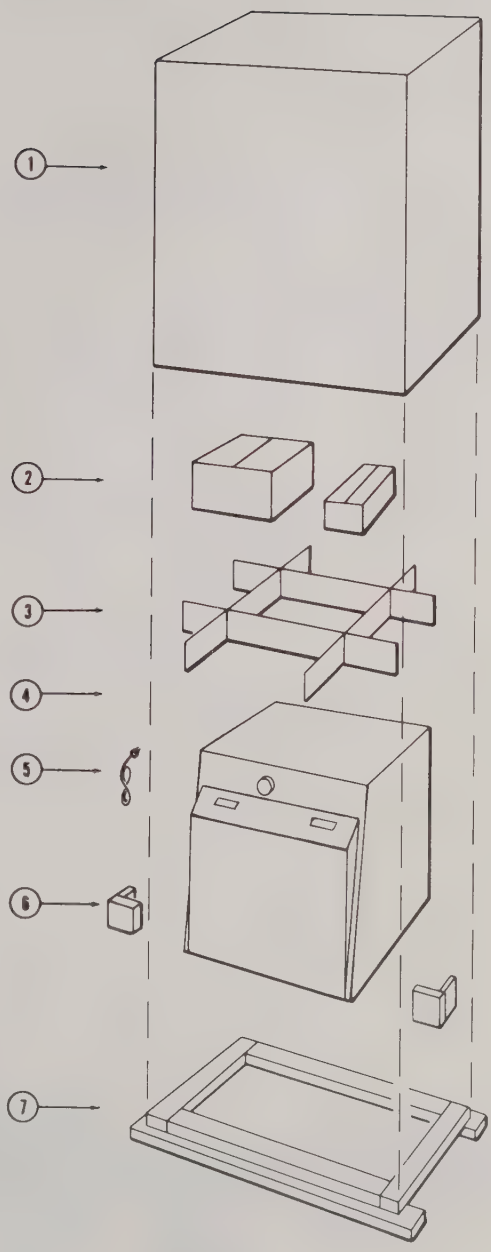


Figure 18. MS-17 Packing

MS-17A . . . . . 8 Amps, 115 Volts, 60 Hz

MS-17AB . . . . . 15 Amps, 115 Volts, 60 Hz

MS-17ABC . . . . . 20 Amps, 115 Volts, 60 Hz

5. Recommended Accessories

   a SC-4 Sensitivity Calibrator, P/N 6130-001-01.

   b Veeco degassing gun, catalog number QD 12500, P/N 4330-000.

B. MS-17A OPERATING INSTRUCTIONS

WARNING

These instructions are not to be used for the MS-17AB or MS-17ABC. Instructions for these units will be found following the MS-17A instructions.

1. Starting From Total Shut Down.

   a. Position of Valves and Control Switches

FOREPUMP . . . . . .OFF	THROTTLE VALVE . . . . CLOSED
DIFFUSION PUMP . . .OFF	ACCUMULATOR VALVE. . . OPEN
ELECTRONICS . . . . . OFF	

   b. Procedure

      1. Plug the power cable into a 115 Volt, 60 Hz source.

      2. Plug cord of leak indicator into console, socket is located on the upper left, rear side of the console.

      3. Turn on the FOREPUMP switch. A gurgling sound will be heard, caused by the high pressure air being exhausted from the pump.

      4. When the forepump stops gurgling (approximately 2 minutes) turn on DIFFUSION PUMP. The FOREPUMP and DIFFUSION PUMP switches are interlocked so that the diffusion pump cannot operate unless the forepump is on.

      5. After about 20 minutes, turn on the ELECTRONICS. The ELECTRONICS switch also turns on the discharge gauge; therefore, it should not be turned on too early or unnecessary contamination of the gauge will result. If the pressure reading is off scale, shut off the ELECTRONICS switch and wait a few minutes. After this time the pressure meter should be on scale. When the pressure is 10^{-4} torr or lower, add liquid nitrogen to the cold trap. (The MS-17 may be operated without liquid nitrogen if necessary, although longer pump-down time will be required). Use the funnel supplied and allow large clearance between the funnel and the fill pipe, so as to allow the gas to escape from the trap. If this procedure is not followed, violent bubbling of the liquid nitrogen will result. Initially, pour a

small charge of liquid nitrogen into the trap, then after three minutes, add sufficient liquid nitrogen to fill the trap. The system pressure should drop to 5×10^{-5} torr or lower in a few minutes.

CAUTION

Never obstruct the filler opening of the cold trap fill pipe as pressure builds up due to nitrogen evaporation.

6. Push FILAMENT ON switch. This should light the EMISSION lamp on the front panel and on the leak indicator. (If the system pressure rises higher than approximately 3×10^{-4}, the filament is automatically turned off).

2. Sensitivity Check

Before using the MS-17A for leak testing, a sensitivity check should be made. At the end of the day, this check should be repeated.

a. Procedure

1. Close the throttle valve and remove the plugs from the port and sensitivity calibrator. Insert the sensitivity calibrator into the test port. Check to see that the valve on the sensitivity calibrator is open so it can be pumped down at the same time the manifold is pumped (see Figure 19).

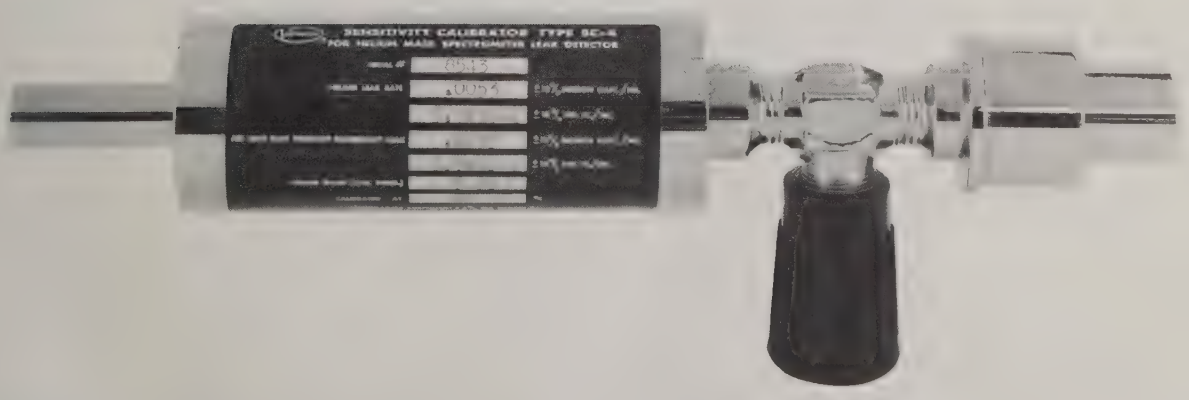


Figure 19. Sensitivity Calibrator, SC-4

2. With FILAMENT OFF, set the leak indicator meter to zero by means of its ZERO ADJUST knob. If necessary use the COARSE ZERO ADJUST control located on the rear of remote box. Push FILAMENT ON switch. It is impossible to perform a test unless the filament is on.

3. Rough down the port manifold by means of an auxiliary vacuum system, and slowly open the THROTTLE VALVE while maintaining the HI-VAC PRESSURE meter reading at 10^{-4} torr or lower. If the pressure is allowed to rise above 3×10^{-4} torr the filament will automatically turn off. If this occurs close the throttle valve slightly and press the FILAMENT ON switch.

4. Valve off the external system. With the throttle valve open full and the filament on, a known (marked on SC-4 sensitivity calibrator) leakage of helium is entering the machine.

5. Note the deflection of the leak Indicator. If it does not correspond to the reading on the SC-4 (for air), adjust the CALIBRATE control (on the rear of the leak indicator) for direct readout. If the setting cannot be reached, see ELECTRICAL ALIGNMENT OF THE CEE TUBE. The MS-17 is now calibrated for Air Leak Rate direct reading, sensitivity is 6×10^{-11} atm cc./sec. which is 2% of the 1st scale.

6. Close the THROTTLE VALVE.

7. Vent the port manifold, remove the sensitivity calibrator, plug end with plastic stopper provided for this purpose.

CAUTION

DO NOT leave the calibrator valve in the closed position. Prolonged closure or excessive closing force may result in permanent damage to the metal-to-metal seat surfaces.

By performing this sensitivity check daily with a known input of Helium, a constant check on the sensitivity of the machine is obtained. More frequent sensitivity checks should be made for larger production loads and more critical tests.

3. Leak Testing

Once the sensitivity check has been accomplished, the MS-17A is ready to perform leak testing. Connect object to be tested to the port desired, "rough" object out, and "throttle" into the leak detec-

tor. When throttling has been completed, spray the test object with helium and observe the leak indicator for deflection.

4. MS-17A Partial Shut-down (e.g., overnight or weekend)

a. Close THROTTLE VALVE.

b. Turn off ELECTRONICS.

5. MS-17A Complete Shut-down

It is recommended that the high vacuum section between the ACCUMULATOR VALVE and the THROTTLE VALVE be left under vacuum to keep the system as clean as possible.

a. Close the ACCUMULATOR VALVE.

b. Turn off the ELECTRONICS.

c. Turn off the DIFFUSION PUMP; note time.

d. If the cold trap bucket is at room temperature, proceed to step h. If bucket is still cold, remove the cold trap bolts to facilitate removal when the system is vented.

e. Open the TEST PORT.

f. Open the THROTTLE VALVE. This vents the system up to the ACCUMULATOR VALVE.

g. Remove the bucket, clean and replace in system.

h. Plug the TEST PORT.

i. After at least 30 minutes following shutting off the DIFFUSION PUMP (step c), open the ACCUMULATOR VALVE. Wait until the FOREPUMP stops "gurgling", then close the ACCUMULATOR VALVE. This evacuates the high vacuum section.

j. Shut off the FOREPUMP

k. Close the THROTTLE VALVE if it is not already closed.

NOTE

If the cold trap is not at room temperature when complete shut down of the system is performed, the cold trap bucket should be removed immediately after venting the system. Any refrigerant remaining in the bucket should be decanted, and the bucket should be wiped with a lint free rag moist-

ened in acetone. Caution should be exercised in the use of acetone. It is highly flammable. After wiping, the bucket should be thoroughly dried (for rapid, efficient drying, the use of a Veeco Degassing Gun, Cat. #QD 12500, is recommended). Once drying has been completed, install the bucket in the cold trap, taking special care to avoid touching vacuum surfaces with fingers. The bucket should be grasped by its top flange only.

C. MS-17AB OPERATING INSTRUCTIONS

1. Starting from Total Shut Down

a. Position of Valves and Control Switches

ROUGHING PUMP	OFF
FOREPUMP	OFF
DIFFUSION PUMP	OFF
THROTTLE VALVE	Open
ACCUMULATOR VALVE	Closed
MODE SWITCH (Sub panel)	MANUAL
START-VENT SWITCH	START
ELECTRONICS	OFF
PORTS	Sealed.

b. Procedure

1. Plug the power cable into 115 volt, 60 Hz source.

2. Plug cord of leak indicator into console. Socket is on upper left, rear side of console.

3. Turn on ROUGHING PUMP and FOREPUMP and wait until both pumps stop "gurgling". Press TEST VALVE OPEN button (this opens the test valve when the mode switch is on MANUAL, allowing quick pump down time) and keep it depressed until the MANIFOLD PRESSURE on the front panel, reads 50 to 70 millitorr.

4. Release the TEST VALVE OPEN button (closing test valve), return the mode switch to AUTOMATIC and the START-VENT switch to the center position. Open the accumulator

valve and turn "ON" DIFFUSION PUMP. Note that REPELLER light goes on at this point insuring self-cleaning action while the diffusion pump is operating. Normally MANIFOLD PRESSURE will rise during warm-up since it is not being pumped during this period.

5. After about 20 minutes, turn on the ELECTRONICS. The ELECTRONICS switch also turns on the Discharge Gauge; therefore, it should not be turned on too early or unnecessary contamination of the gauge will result. If the pressure reading is off scale, shut off the ELECTRONICS and wait a few minutes. After this time the PRESSURE meter should indicate on scale. When the pressure is approximately 1×10^{-4} torr or lower, add a small charge of liquid nitrogen to the cold trap. Use the funnel and allow for displaced air to escape from the cold trap. If this is not done, violent bubbling will result. After about three minutes, add sufficient liquid nitrogen to fill the trap. The pressure in the leak detector should drop to 5×10^{-5} torr or lower in a few minutes.

6. Push the FILAMENT ON switch. Emission lamp on front panel should light. (If pressure rises above 3×10^{-4} torr, the filament is automatically turned off.)

2. Sensitivity Check

Before using the MS-17AB for leak testing, a sensitivity check must be made (it is assumed the system is in operation). During the day, this check should be repeated.

a. Procedure

1. Place the mode switch in the AUTOMATIC position.

2. With FILAMENT OFF, set the leak indicator meter to zero by means of its ZERO ADJUST knob. The ZERO should be set on the most sensitive scale (3×10^{-9}). If necessary use the COARSE ZERO ADJUST BALANCE control located on the rear of remote box. Push FILAMENT ON switch. It is impossible to perform a test unless the filament is on and the throttle valve is open.

3. Press START-VENT switch to VENT for a few seconds until the MANIFOLD PRESSURE meter moves up-scale, then release. This switch is spring loaded and will return to neutral. Set the crossover point to a safe pressure (20 millitorr or lower). This setting determines when the test valve will open, tying the test manifold in with the spectrometer tube.

4. Remove plugs from the port and the sensitivity calibrator, and insert the sensitivity calibrator into the Test Port. Check to see that the valve on the Sensitivity Calibrator is open.

5. Place the START-VENT Switch in the START position. The calibrator is evacuated until the manifold pressure reaches crossover. At this point the Test Valve opens, the TEST Light goes on, and the Roughing Valve closes.

NOTE

If, while in this position, high pressure due to outgassing, external leaks, etc. is inadvertently introduced to the leak detector the filament protective interlock with the discharge gauge will be actuated and the filament will be turned off, the test valve will close, and the roughing valve will open. The roughing valve will remain open unless the START-VENT Switch is moved to its center position. Testing can be resumed when the difficulty is cleared and the filament is operating. The filament must be manually reset by pushing the FILAMENT "ON" switch.

6. When the TEST light is on, the machine is ready for a sensitivity check. Proceed as follows:

   a. Read leak indicator meter and set for direct readout using the air leak rate figure on the sensitivity calibrator. If necessary, adjust using the calibration potentiometer on rear of remote box. If direct reading cannot be obtained with the gain potentiometer, the mass spectrometer tube should be retuned for maximum signal and the calibration reset.

   b. Close sensitivity calibrator valve.

   c. The leak indicator meter should return to zero, or near zero. The difference between the two readings is the output due to helium in-leakage from the sensitivity calibrator.

NOTE

By performing this sensitivity check daily with a known input of helium, a constant check on the sensitivity of the machine is obtained.

7. Upon completion of sensitivity check, move the START-VENT Switch to the VENT position. This will vent the calibrator and the manifold. Remove the sensitivity calibrator from the port. Plug the sensitivity calibrator with the plastic stopper provided and open the valve on the sensitivity calibrator.

3. Leak Testing With Mode Switch In AUTOMATIC

Once the sensitivity check has been accomplished, the MS-17AB is ready to perform leak testing. Connect the object to be tested to the port. Press the FILAMENT "ON" switch if the filament is not already on, and move the START-VENT switch to START. The Roughing Light will go on, indicating the object is being evacuated. When the TEST light goes on, proceed to spray the object with helium and observe the leak indicator for deflection (or audible indication). At the completion of the leak test, move the START-VENT switch to VENT, hold for 2 seconds or more (depending on the volume of the piece being tested) and release, remove the object under test.

4. Leak Testing With Mode Switch in MANUAL (Throttle)

This position is provided to allow manual control of the vacuum valves for special testing conditions. It is employed when either excessive leakage or outgassing of the test object will not permit automatic operation of the Test Valve.

a. Procedure

1. Shut the Throttle Valve. It is essential that this step be performed first, since placing the mode switch in MANUAL (Throttle) position bypasses the MANIFOLD PRESSURE controller interlock, allowing the Test Valve to open immediately when the START-VENT Switch is placed in the START position and the filament is turned on. As an added safety the filament turns off automatically when the mode switch is put in MANUAL, if the START-VENT switch is in the center position.

2. Place mode switch in MANUAL (Throttle) position.

3. Connect test object to one of the ports.

4. Place START-VENT Switch in START position, and turn on the filament. Note that the TEST VALVE Light goes on. This indicates that the test valve can open. The test valve will not open until the THROTTLE VALVE is operated since the THROTTLE VALVE is a manual override of the test valve and the THROTTLE VALVE is closed at this point. Should the filament go off due to high pressure, the test valve will shut, thereby protecting the diffusion pump oil from oxidation through exposure to atmospheric pressure.

5. When the Pirani gauge reads 100 millitorr or less, slowly open the throttle valve while maintaining the HI-VAC PRESSURE reading at 10^{-4} torr or lower. (If the

pressure accidentally rises above 3 x 10^{-4} torr and the filament goes out, close the Throttle Valve slightly and reset the filament by pressing the FILAMENT ON switch). When the Filament goes on, the test valve simultaneously opens allowing the test to proceed.

When the Throttle Valve can be opened no further, as indicated by the pressure meter rising to 3 x 10^{-4}, testing may proceed. Spray the object with helium, and observe the leak indicator.

6. After testing, place the mode switch back in AUTOMATIC and open the throttle valve fully if normal testing is to be resumed. If checking other large, "gassy" volumes, or suspected large leakers, leave the mode switch in MANUAL, and close the Throttle Valve before venting. The filament will turn off when the machine is vented so that the test valve will not open, the filament must be turned on during each manual test.

7. Move the START-VENT Switch to VENT and release.

8. Remove object under test.

5. Temporary Shut-Down

a. Procedure For Overnight Shut-Down (Standby) with Leak Detector Pumps Running (THROTTLE VALVE Open)

1. Seal off the test port.

2. Place START-VENT switch in START position, as in normal testing, (switch in AUTOMATIC position) until the test valve opens.

3. Turn off the ELECTRONICS. The test valve will stay open. If for some reason the pressure should rise above the crossover point, the test valve will close, thus protecting the diffusion pump.

6. Starting Up From Overnight Shut-Down With Leak Detector Pumps Already Running

a. Procedure

1. Turn on ELECTRONICS.

2. Put liquid nitrogen in cold trap if pressure is below 10^{-4} torr on HI-VAC pressure meter.

3. A sensitivity check must be made at this time.

4. Follow testing procedure for specific type of testing desired.

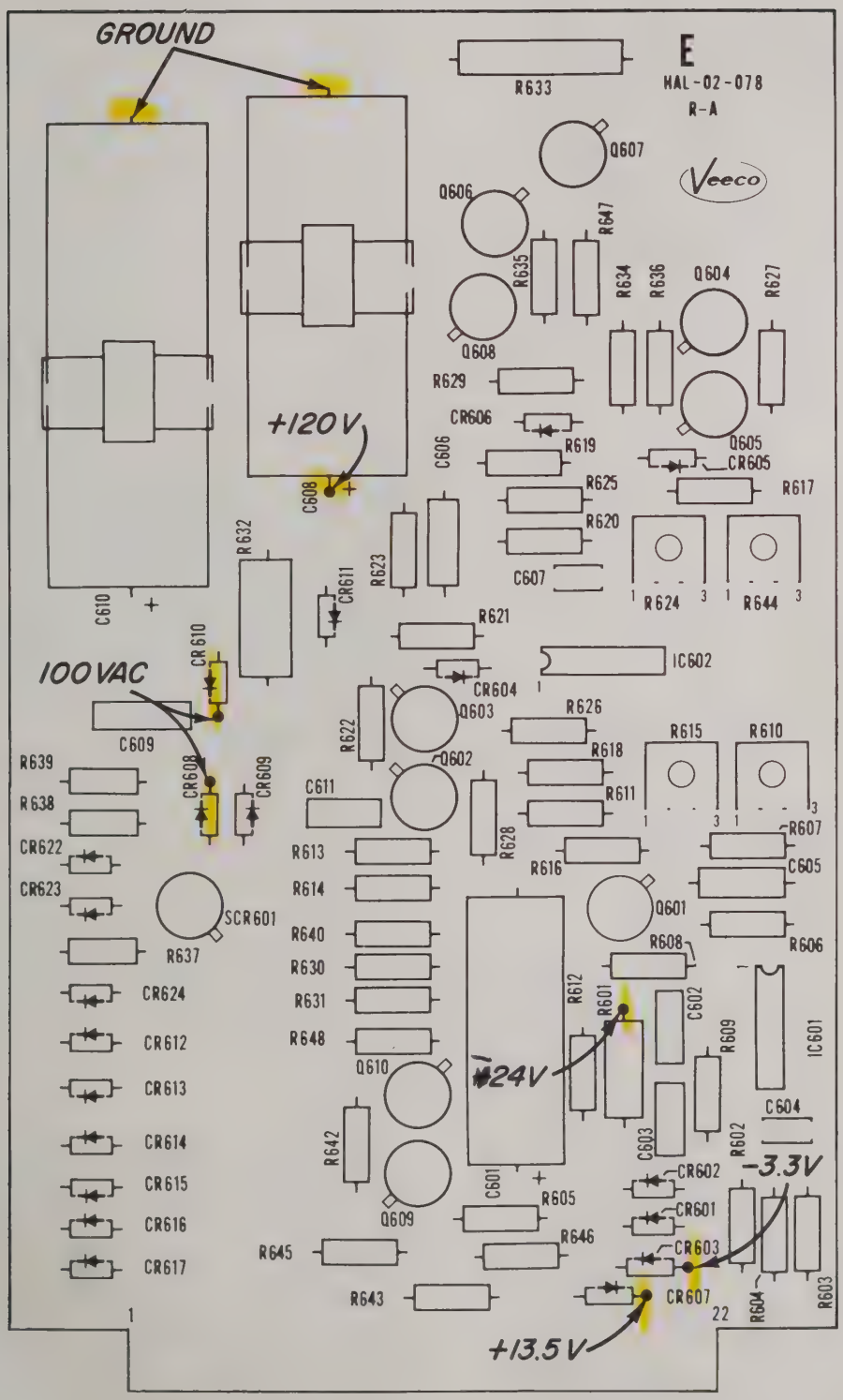


Figure 26. Circuit Board "E", Voltage Check Points

SYMPTOMS	CAUSE and/or REMEDY
Leak indicator meter erratic or pegs downscale.	Contaminated Discharge Gauge. (See cleaning procedure). Faulty T-3 transformer Faulty circuit board "C" Leaky high voltage cable; inspect Discharge Gauge component board (board "C") and blow clean with dry air. Faulty circuit board "A" Poor electrical ground. External causes such as sparking electrical equipment or large sources of R.F. energy nearby. Low line voltage. Contaminated plumbing.
Leak indicator meter fails to operate.	Meter not plugged into rear of cabinet. ELECTRONICS switch off. Faulty circuit board "A".
HI-VAC PRESSURE meter fails to operate.	Check High Voltage connector on flange of discharge gauge.

WARNING

TURN OFF ELECTRONICS; HIGH VOLTAGE PRESENT IN THIS CIRCUIT.

HI-VAC PRESSURE meter fails to operate. (Cont'd)

CAUTION

Turn off Electronics if this needs adjustment. Check circuit board "C" Check C301 for shorts. Check R302, R303 and R304. Faulty T3 high voltage transformer.

HI-VAC PRESSURE meter reads off scale, high.	High pressure due to leaks from atmosphere, outgassing of equipment attached to MS-17, high vapor pressure products from pump oils (such as water), or contaminants from decomposed diffusion pump oils. Diffusion Pump not turned on, or heater for diffusion pump not operating. Leaks may occur past "O" ring valve seals due to lint and similar foreign particles.

SYMPTOMS	CAUSE and/or REMEDY
HI-VAC PRESSURE meter erratic.	Contaminated Discharge Gauge, contaminated Vacuum System. See cleaning procedure. Faulty circuit board "C" Electrical shorts in high voltage or component board.
EMISSION meter fails to operate.	ELECTRON FOCUS improperly set. "Cee" tube filament open. Contacts on PRESSURE-EMISSION switch dirty or bent. Faulty circuit board "A"
MANIFOLD PRESSURE pegs upscale	Open Pirani tube; dirty Discharge Gauge tube.
EMISSION meter reads low (below 1 mA).	ELECTRON FOCUS not properly adjusted. Faulty circuit board "A" Defective or weak filament, switch filament or replace.
EMISSION meter reads high (over 4 mA).	ELECTRON FOCUS not properly set. Faulty P.C. board "A" Check for short between points A & B of ion source. Remove source and clean area where filament is located. Also check electron focus potentiometer.
Leak meter fails to detune when HELIUM SCAN switch is moved to the HIGH position. Excessive background	Cee tube dirty; remove stain from vertex of spectrometer tube by physically abrading surface. Follow general cleaning procedure of the "Cee" tube.
Vent valve does not open after 1 sec. upon moving switch to VENT position	Open Solenoid coil. Faulty board "E"
Excessive pressure rise in high vacuum section when test valve opens.	Accumulation of dirt in Test Manifold. Vent valve leaking, due to dirt on seat. Remove and clean. Leak, or excessive outgassing from test piece or connection(s). MANIFOLD PRESSURE controller (test manifold) set too high.
Leak in test manifold.	Check especially side flange and top quick coupling openings.

SYMPTOMS	CAUSE and/or REMEDY
Vent valve leaking	Clean seat
Fluctuating helium signal slow recovery after closing calibrator. Poor ultimate pressure.	Check diffusion Pump. Check diffusion pump blower. Dirty discharge gauge, check cabinet air filters.
Frequent filament burnout	Crossover point on MANIFOLD PRESSURE Controller set too high. Reset crossover point. Check if high voltage lead to discharge gauge is connected properly. Continued operation at high pressures due to contaminated system. (10^{-4} and 10^{-5} torr scales.) Clean vacuum system and replace O-rings. Filament voltage set too high (check as per III, E, 1, a-h)
Solenoid Valves in "B" block fail to operate.	Check 2 Amp fuse in sub panel Check for operation of solenoid valves in electronics box Check diodes for open or short circuits on circuit board "E"
High pressire air burst to "Cee" tube when venting.	Leak past test valve seat. Disassemble, clean valve, giving giving special attention to removal of foreign material from "O" rings and "O" ring grooves. Vent solenoid valve in "B" block opens too soon, or test solenoid valve does not close soon enough.
Roughing pump breaker kicks off upon start-up.	Pump improperly shut down - run vented to atmosphere for at least one minute. Pump oil cold - run vented to atmosphere for at least one minute. Pump belt too tight.
Pump gurgling when backfilling port is vented, and/or pumping away fill gas as noted on pressure gauge for "C" block.	Solenoid valve in "C" Block fails to close properly. Disassemble and clean valve, giving special attention to removal of foreign material from "O" ring and "O" ring groove. "O" ring seal facing wrong way. It should be facing the pump.

SYMPTOMS	CAUSE and/or REMEDY
Roughing pump gurgles whenever Roughing or Test Valve is operated.	Normal, valves are vacuum operated and get their vacuum from the roughing pump.

D. INDICATIONS OF A CONTAMINATED VACUUM SYSTEM

1. HI-VAC Pressure Meter Off Scale

After approximately 25 minutes pump down time, the pressure meter should indicate less than 1 micron. If the pressure meter indicates above 1 micron it may be due to a contaminated system. High pressure readings may, however, be due to causes other than a contaminated system. These should be eliminated prior to suspecting contamination. They are:

a. Electrical short circuit in the discharge gauge cable or circuit

b. Loose mechanical pump belt, or greasy mechanical pump belt.

c. Diffusion pump oil and/or forepump oil badly contaminated.

d. Diffusion pump heater not operating.

e. Leak in the vacuum system.

f. Contaminated discharge gauge.

g. Liquid nitrogen trap recently run dry, permitting water to evaporate.

If Steps a to f check out properly it may be concluded that the system is contaminated. Contamination may have occurred due to the repeated connection of unclean objects to the test port, or from the backstreaming and subsequent deposit on the system walls of decomposition products from diffusion pump oil. Diffusion pump oil (Octoil in this case) will be decomposed if exposed to air while at operating temperature. If the oil has been decomposed (or "cracked") by air exposure, an acrid smell will be present at the mechanical pump exhaust.

When it has been established that contamination is the cause of the high pressure reading, the entire vacuum system should be cleaned, and a new charge of oil should be added to the diffusion pump and the mechanical pump as well.

2. Background

Another indication of a contaminated system is called "background." Background is caused by testing objects that are contamin-

ated with lubricating oils, etc., or by operation with a contaminated auxiliary set-up.

NOTE

Quite often the removal of background can be effected by warming the contaminated areas with a Veeco Degassing Gun while the system is pumping. This is the simplest method and should be tried before disassembly of vacuum plumbing.

The HELIUM SCAN switch located on the main panel is provided in order to determine the decrease in signal ±30 Volts either side of the helium peak. Holding the switch up to HIGH (voltage) (with helium entering the Cee tube) should cause the leak indicator meter to decrease; if it remains about the same or increases, then low-side background exists. Likewise, if the meter rises when the switch is held down to LOW (voltage), high-side background exists.

If "background" exists, that tends to obscure the true helium peak, the sensitivity of the detector is impaired and the situation should be corrected immediately by cleaning the contaminated sections. (Refer to general remarks on cleaning procedure.)

3. Location of Contaminated Sections

a. Isolate objects to be tested, and/or auxiliary set-ups from the MS-17; plug the ports and place in TEST condition.

b. If background remains, after step a, close the THROTTLE VALVE. If the background disappears, then the vacuum lines from the THROTTLE VALVE to the ports, the test valve, vent valve and/or the oil in the roughing pump should be suspected as the source of the contamination.

c. If background remains after step b, turn off the ELECTRONICS, turn off the DIFFUSION PUMP, remove the source cable and allow 10 to 15 minutes for the diffusion pump to cool. Vent the system (through the THROTTLE VALVE) drain and flush the forepump with clean Duo-Seal Oil, fill forepump to proper level and start up system according to normal operating procedures. Replace source cable after "Cee" tube has been evacuated.

d. Finally, if background still remains, the system should be shut down again and the diffusion pump, "Cee" tube, and cold trap thoroughly cleaned.

tor. When throttling has been completed, spray the test object with helium and observe the leak indicator for deflection.

4. MS-17A Partial Shut-down (e.g., overnight or weekend)

a. Close THROTTLE VALVE.

b. Turn off ELECTRONICS.

5. MS-17A Complete Shut-down

It is recommended that the high vacuum section between the ACCUMULATOR VALVE and the THROTTLE VALVE be left under vacuum to keep the system as clean as possible.

a. Close the ACCUMULATOR VALVE.

b. Turn off the ELECTRONICS.

c. Turn off the DIFFUSION PUMP; note time.

d. If the cold trap bucket is at room temperature, proceed to step h. If bucket is still cold, remove the cold trap bolts to facilitate removal when the system is vented.

e. Open the TEST PORT.

f. Open the THROTTLE VALVE. This vents the system up to the ACCUMULATOR VALVE.

g. Remove the bucket, clean and replace in system.

h. Plug the TEST PORT.

i. After at least 30 minutes following shutting off the DIFFUSION PUMP (step c), open the ACCUMULATOR VALVE. Wait until the FOREPUMP stops "gurgling", then close the ACCUMULATOR VALVE. This evacuates the high vacuum section.

j. Shut off the FOREPUMP

k. Close the THROTTLE VALVE if it is not already closed.

NOTE

If the cold trap is not at room temperature when complete shut down of the system is performed, the cold trap bucket should be removed immediately after venting the system. Any refrigerant remaining in the bucket should be decanted, and the bucket should be wiped with a lint free rag moist-

ened in acetone. Caution should be exercised in the use of acetone. It is highly flammable. After wiping, the bucket should be thoroughly dried (for rapid, efficient drying, the use of a Veeco Degassing Gun, Cat. #QD 12500, is recommended). Once drying has been completed, install the bucket in the cold trap, taking special care to avoid touching vacuum surfaces with fingers. The bucket should be grasped by its top flange only.

C. MS-17AB OPERATING INSTRUCTIONS

1. Starting from Total Shut Down

a. Position of Valves and Control Switches

ROUGHING PUMP	OFF
FOREPUMP	OFF
DIFFUSION PUMP	OFF
THROTTLE VALVE	Open
ACCUMULATOR VALVE	Closed
MODE SWITCH (Sub panel)	MANUAL
START-VENT SWITCH	START
ELECTRONICS	OFF
PORTS	Sealed.

b. Procedure

1. Plug the power cable into 115 volt, 60 Hz source.

2. Plug cord of leak indicator into console. Socket is on upper left, rear side of console.

3. Turn on ROUGHING PUMP and FOREPUMP and wait until both pumps stop "gurgling". Press TEST VALVE OPEN button (this opens the test valve when the mode switch is on MANUAL, allowing quick pump down time) and keep it depressed until the MANIFOLD PRESSURE on the front panel, reads 50 to 70 millitorr.

4. Release the TEST VALVE OPEN button (closing test valve), return the mode switch to AUTOMATIC and the START-VENT switch to the center position. Open the accumulator

valve and turn "ON" DIFFUSION PUMP. Note that REPELLER light goes on at this point insuring self-cleaning action while the diffusion pump is operating. Normally MANIFOLD PRESSURE will rise during warm-up since it is not being pumped during this period.

5. After about 20 minutes, turn on the ELECTRONICS. The ELECTRONICS switch also turns on the Discharge Gauge; therefore, it should not be turned on too early or unnecessary contamination of the gauge will result. If the pressure reading is off scale, shut off the ELECTRONICS and wait a few minutes. After this time the PRESSURE meter should indicate on scale. When the pressure is approximately 1×10^{-4} torr or lower, add a small charge of liquid nitrogen to the cold trap. Use the funnel and allow for displaced air to escape from the cold trap. If this is not done, violent bubbling will result. After about three minutes, add sufficient liquid nitrogen to fill the trap. The pressure in the leak detector should drop to 5×10^{-5} torr or lower in a few minutes.

6. Push the FILAMENT ON switch. Emission lamp on front panel should light. (If pressure rises above 3×10^{-4} torr, the filament is automatically turned off.)

2. Sensitivity Check

Before using the MS-17AB for leak testing, a sensitivity check must be made (it is assumed the system is in operation). During the day, this check should be repeated.

a. Procedure

1. Place the mode switch in the AUTOMATIC position.

2. With FILAMENT OFF, set the leak indicator meter to zero by means of its ZERO ADJUST knob. The ZERO should be set on the most sensitive scale (3×10^{-9}). If necessary use the COARSE ZERO ADJUST BALANCE control located on the rear of remote box. Push FILAMENT ON switch. It is impossible to perform a test unless the filament is on and the throttle valve is open.

3. Press START-VENT switch to VENT for a few seconds until the MANIFOLD PRESSURE meter moves up-scale, then release. This switch is spring loaded and will return to neutral. Set the crossover point to a safe pressure (20 millitorr or lower). This setting determines when the test valve will open, tying the test manifold in with the spectrometer tube.

4. Remove plugs from the port and the sensitivity calibrator, and insert the sensitivity calibrator into the Test Port. Check to see that the valve on the Sensitivity Calibrator is open.

5. Place the START-VENT Switch in the START position. The calibrator is evacuated until the manifold pressure reaches crossover. At this point the Test Valve opens, the TEST Light goes on, and the Roughing Valve closes.

NOTE

If, while in this position, high pressure due to outgassing, external leaks, etc. is inadvertently introduced to the leak detector the filament protective interlock with the discharge gauge will be actuated and the filament will be turned off, the test valve will close, and the roughing valve will open. The roughing valve will remain open unless the START-VENT Switch is moved to its center position. Testing can be resumed when the difficulty is cleared and the filament is operating. The filament must be manually reset by pushing the FILAMENT "ON" switch.

6. When the TEST light is on, the machine is ready for a sensitivity check. Proceed as follows:

   a. Read leak indicator meter and set for direct readout using the air leak rate figure on the sensitivity calibrator. If necessary, adjust using the calibration potentiometer on rear of remote box. If direct reading cannot be obtained with the gain potentiometer, the mass spectrometer tube should be retuned for maximum signal and the calibration reset.

   b. Close sensitivity calibrator valve.

   c. The leak indicator meter should return to zero, or near zero. The difference between the two readings is the output due to helium in-leakage from the sensitivity calibrator.

NOTE

By performing this sensitivity check daily with a known input of helium, a constant check on the sensitivity of the machine is obtained.

7. Upon completion of sensitivity check, move the START-VENT Switch to the VENT position. This will vent the calibrator and the manifold. Remove the sensitivity calibrator from the port. Plug the sensitivity calibrator with the plastic stopper provided and open the valve on the sensitivity calibrator.

3. Leak Testing With Mode Switch In AUTOMATIC

Once the sensitivity check has been accomplished, the MS-17AB is ready to perform leak testing. Connect the object to be tested to the port. Press the FILAMENT "ON" switch if the filament is not already on, and move the START-VENT switch to START. The Roughing Light will go on, indicating the object is being evacuated. When the TEST light goes on, proceed to spray the object with helium and observe the leak indicator for deflection (or audible indication). At the completion of the leak test, move the START-VENT switch to VENT, hold for 2 seconds or more (depending on the volume of the piece being tested) and release, remove the object under test.

4. Leak Testing With Mode Switch in MANUAL (Throttle)

This position is provided to allow manual control of the vacuum valves for special testing conditions. It is employed when either excessive leakage or outgassing of the test object will not permit automatic operation of the Test Valve.

a. Procedure

1. Shut the Throttle Valve. It is essential that this step be performed first, since placing the mode switch in MANUAL (Throttle) position bypasses the MANIFOLD PRESSURE controller interlock, allowing the Test Valve to open immediately when the START-VENT Switch is placed in the START position and the filament is turned on. As an added safety the filament turns off automatically when the mode switch is put in MANUAL, if the START-VENT switch is in the center position.

2. Place mode switch in MANUAL (Throttle) position.

3. Connect test object to one of the ports.

4. Place START-VENT Switch in START position, and turn on the filament. Note that the TEST VALVE Light goes on. This indicates that the test valve can open. The test valve will not open until the THROTTLE VALVE is operated since the THROTTLE VALVE is a manual override of the test valve and the THROTTLE VALVE is closed at this point. Should the filament go off due to high pressure, the test valve will shut, thereby protecting the diffusion pump oil from oxidation through exposure to atmospheric pressure.

5. When the Pirani gauge reads 100 millitorr or less, slowly open the throttle valve while maintaining the HI-VAC PRESSURE reading at 10^{-4} torr or lower. (If the

pressure accidentally rises above 3 x 10^{-4} torr and the filament goes out, close the Throttle Valve slightly and reset the filament by pressing the FILAMENT ON switch). When the Filament goes on, the test valve simultaneously opens allowing the test to proceed.

When the Throttle Valve can be opened no further, as indicated by the pressure meter rising to 3 x 10^{-4}, testing may proceed. Spray the object with helium, and observe the leak indicator.

6. After testing, place the mode switch back in AUTOMATIC and open the throttle valve fully if normal testing is to be resumed. If checking other large, "gassy" volumes, or suspected large leakers, leave the mode switch in MANUAL, and close the Throttle Valve before venting. The filament will turn off when the machine is vented so that the test valve will not open, the filament must be turned on during each manual test.

7. Move the START-VENT Switch to VENT and release.

8. Remove object under test.

5. Temporary Shut-Down

a. Procedure For Overnight Shut-Down (Standby) with Leak Detector Pumps Running (THROTTLE VALVE Open)

1. Seal off the test port.

2. Place START-VENT switch in START position, as in normal testing, (switch in AUTOMATIC position) until the test valve opens.

3. Turn off the ELECTRONICS. The test valve will stay open. If for some reason the pressure should rise above the crossover point, the test valve will close, thus protecting the diffusion pump.

6. Starting Up From Overnight Shut-Down With Leak Detector Pumps Already Running

a. Procedure

1. Turn on ELECTRONICS.

2. Put liquid nitrogen in cold trap if pressure is below 10^{-4} torr on HI-VAC pressure meter.

3. A sensitivity check must be made at this time.

4. Follow testing procedure for specific type of testing desired.

7. Complete Shut-Down

It is recommended that the high vacuum section between the ACCUMULATOR VALVE and the THROTTLE VALVE be left under vacuum to keep the system as clean as possible.

a. Procedure

Initial condition is in the AUTOMATIC mode, with the system vented (Throttle valve open)

1. Place the MODE switch in MANUAL.

2. Close the ACCUMULATOR VALVE by pushing the knob in.

3. Turn off the ELECTRONICS.

4. Turn off the DIFFUSION PUMP - Note time.

5. If the cold trap bucket is at room temperature, proceed to step 10. If the bucket is cold, it must be removed and cleaned. Remove the bucket bolts to facilitate its removal when the system is vented.

6. Press the START-VENT switch to VENT and hold, while also pressing the TEST VALVE - PUSH TO OPEN switch. This opens the test valve and the vent valve to vent the system up to the accumulator valve. Release both switches.

7. Immediately remove the cold trap bucket by lifting straight up. Pour off the remaining liquid nitrogen. Heat to melt the ice on the outside of the bucket. Wipe bucket dry and then clean with solvent (acetone). After cleaning, handle the bucket by the top flange only to avoid fingerprinting the surfaces exposed to high vacuum. Dry the bucket with a Veeco heat gun. Lightly grease the cold trap "O-ring" and install the bucket back in the cold trap. Replace bolts.

8. Blank off the port if it is not already blanked.

9. Place the START-VENT switch in the START position. Press the TEST VALVE-PUSH TO OPEN switch until the MANIFOLD PRESSURE reads 50 millitorr, then release.

10. Place the START-VENT switch in VENT position for a few seconds, then release.

11. Remove the port plug.

12. Close the THROTTLE VALVE, thereby isolating the high vacuum section.

13. After more than 30 minutes have elapsed since shutting off the DIFFUSION PUMP in step 4, shut off the FORE-PUMP.

14. Place the START-VENT in the START position and shut off the ROUGHING pump while it "gurgles".

15. Plug the PORT to prevent contaminants from entering the system.

D. MS-17ABC OPERATING INSTRUCTIONS (See Figure 20)

1. General

This is essentially an MS-17AB with a backfill table attached. This backfill section has its own 10' power cable which must be plugged into a 115V 60 Hz 8 Amp power source. The backfill section has a stainless steel, two port bell-jar baseplate. A mechanical pump, controlled by a circuit breaker on the front control panel, is provided to evacuate the test object and/or bell jar. A solenoid valve between the port and the pump is actuated by a toggle switch (marked ROUGHING VALVE) on the upper left side front control panel. With this switch in the ON position, the valve is open, as indicated by a red light, and the backfill port is evacuated. With this switch in the OFF position, the valve is closed and the red light is off.

The state of vacuum or pressure at the fill port is indicated by a Bourdon type gauge.

Three toggle valves control FILL gas, HELIUM and AIR on the control panel. The FILL and HELIUM gas lines are needle valved for more accurate control. The needle valves may be left open at a desired flow rate, and the toggle valves used for gas control in repetitive operations.

Additionally, a needle valve and a toggle valve on the lower control panel, control the Helium Probe flow. This probe is attached to a fitting on the right rear of the table top.

2. Backfilling

(Example) To back-fill with 20% Helium and 80% FILL gas at atmospheric pressure proceed as follows:

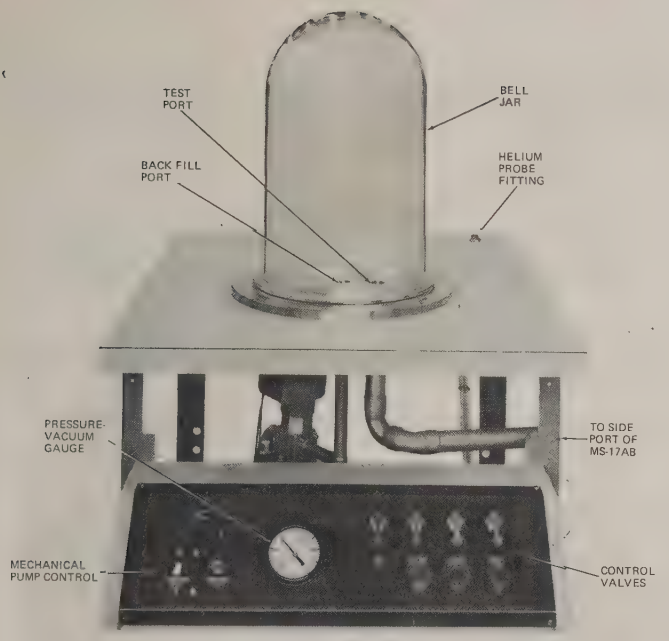
a. Procedure

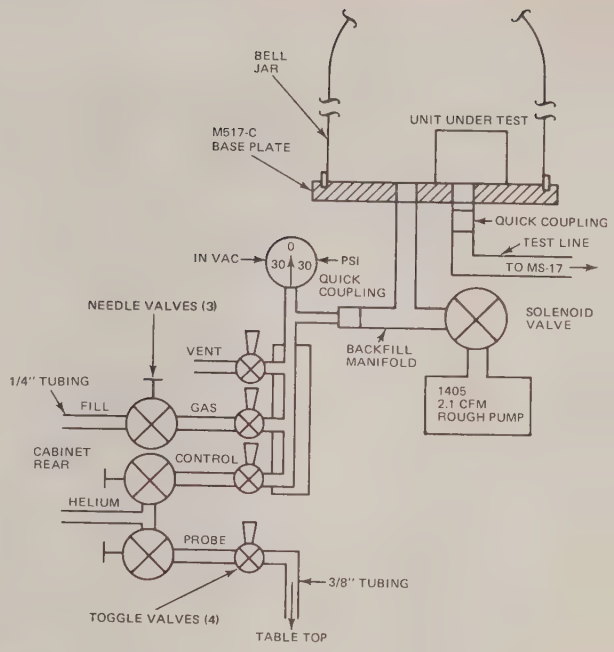
1. Connect the unit to be filled to back-fill port.

2. Turn on the ROUGHING PUMP to back-fill section.

3. Toggle Valves - closed

4. Turn the ROUGHING VALVE switch on - opening solenoid valve.





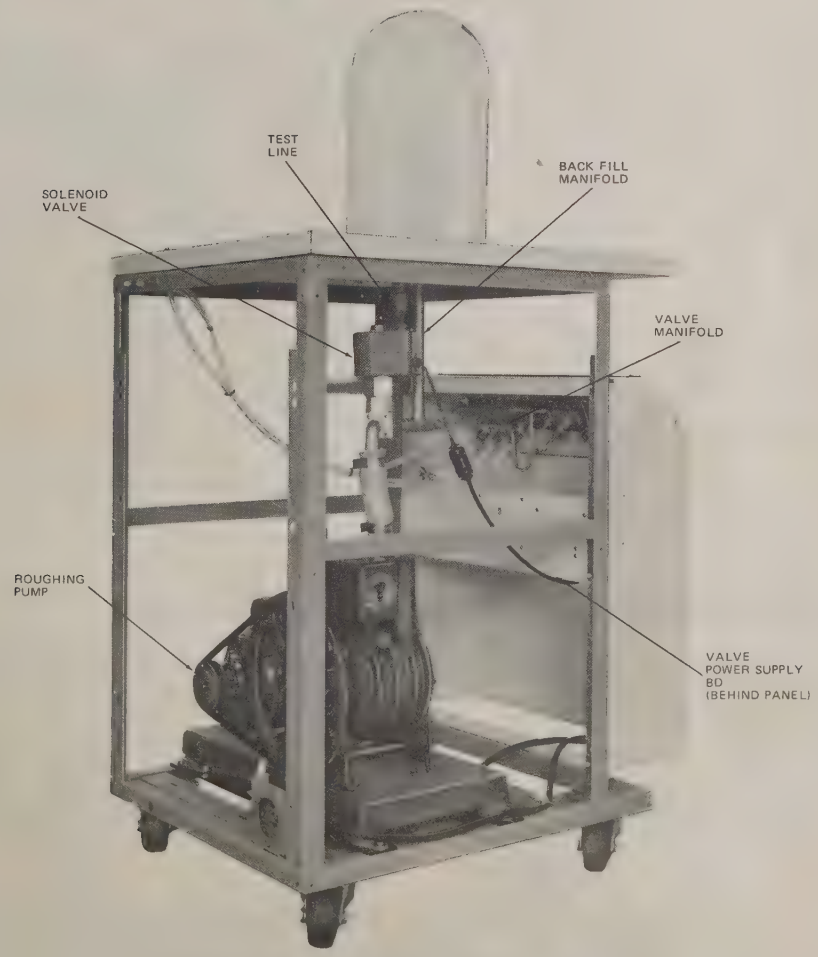


Figure 20. MS-17ABC, C Module

5. When pressure on Bourdon gauge reads about 30" vacuum, turn the Roughing Valve switch off. This shuts the solenoid valve.

6. Admit the gas that comprises the minor component of the backfill mixture and then admit the major portion. This will cause the greatest turbulence, aiding rapid mixing.

Open the HELIUM CONTROL toggle and flow valves until the Bourdon gauge indicates a pressure rise of 6". (6" corresponds to 6/30 or 20% pressure rise). The gauge should now read 24" vacuum.

Close the HELIUM CONTROL toggle and open the FILL GAS CONTROL toggle and flow valve. These valves should remain open until the Bourdon gauge reads zero, or atmospheric pressure. (The fill gas caused an additional 24" rise in pressure, indicating a flow of 24/30, or 80% fill gas).

3. Leak Testing After Backfilling

After performing the back-filling operations, the filled unit may easily be leak tested while remaining on the same port. Remove the plug, if any, from the base plate test port. Place a bell jar over the unit and vacuum leak test, but remember the leak rates as shown on the leak indicator meter are directly proportional to the percentage of Helium in the backfill mixture.

NOTE

The quick coupling port on top of the MS-17AB MUST BE CLOSED IN ORDER TO LEAK TEST. Any unit on the bell jar plate may be automatically tested per operating instructions for the MS-17AB since all test ports on the MS-17ABC have a common manifold.

E. ELECTRICAL ALIGNMENT OF THE CEE TUBE (TUNING)

Electrical alignment of the Cee Tube is accomplished by the proper setting of six controls which are located on the sub panel. These controls are:

1. EMISSION	3. ION CENTER	4. PEAK TUNE
2. ION FOCUS	4. REPELLER	6. FILAMENT VOLTAGE

The procedure below is to be used when a complete realignment is necessary. For example when changing a source. Generally, "tuning" the machine only involves small changes in any control.

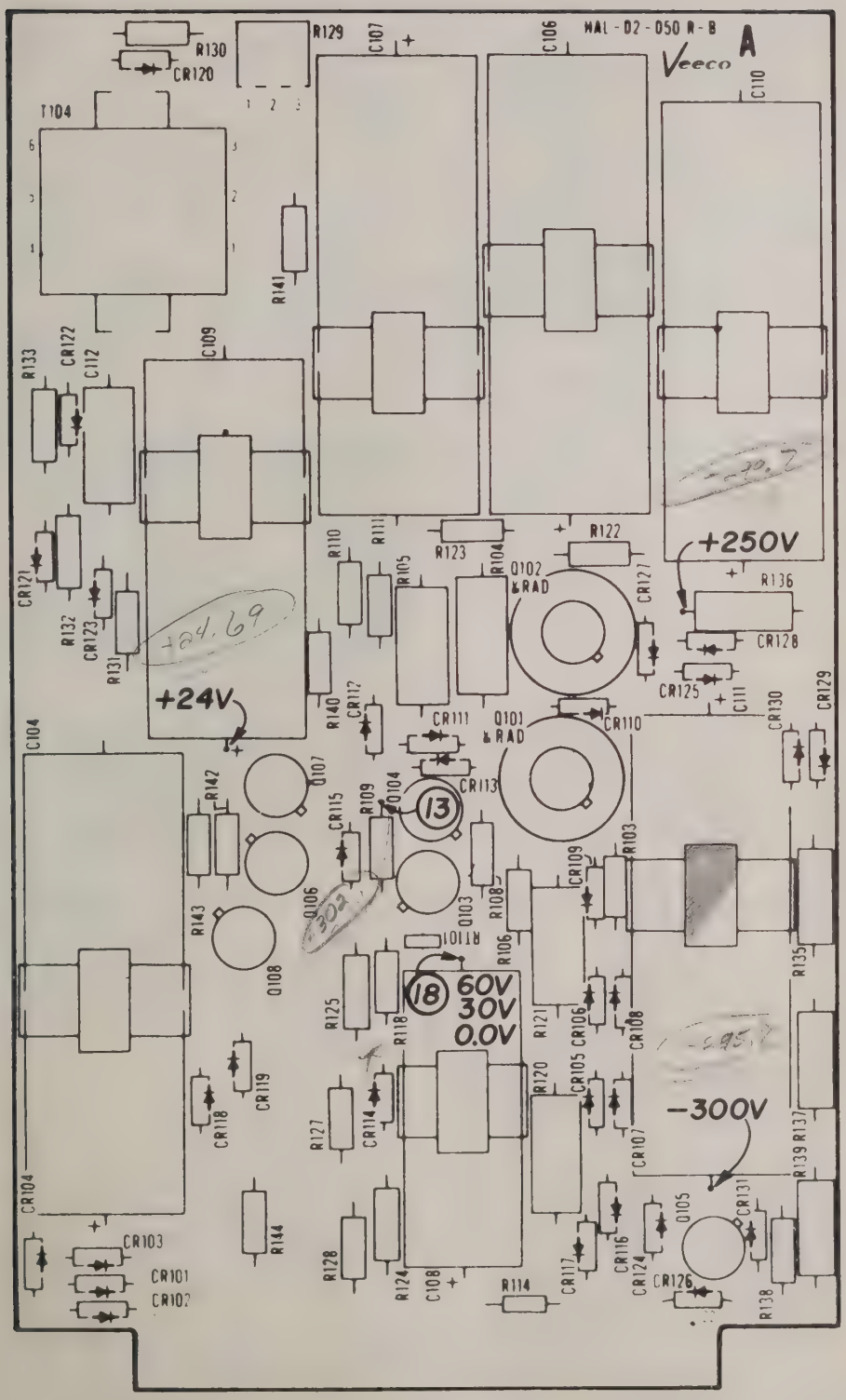


Figure 23. Circuit Board "A", Voltage Check Points

NOTE

Point 18 should be +30V with helium scan switch in Normal position
+60V with helium scan switch in High Position
0V with helium scan switch in Low position
Point 13 varies with Peak Tune Variations. When tuned should be approximately 270 Volts.

2. Board "B" (See Figure 24)

The voltages shown are relative to ground, except the +12V and +5V points which are relative to the negative end of C209, since this is an isolated power supply.

3. Board "C" (See Figure 25)

Board "C" is the high voltage supply and its voltage is measured as indicated.

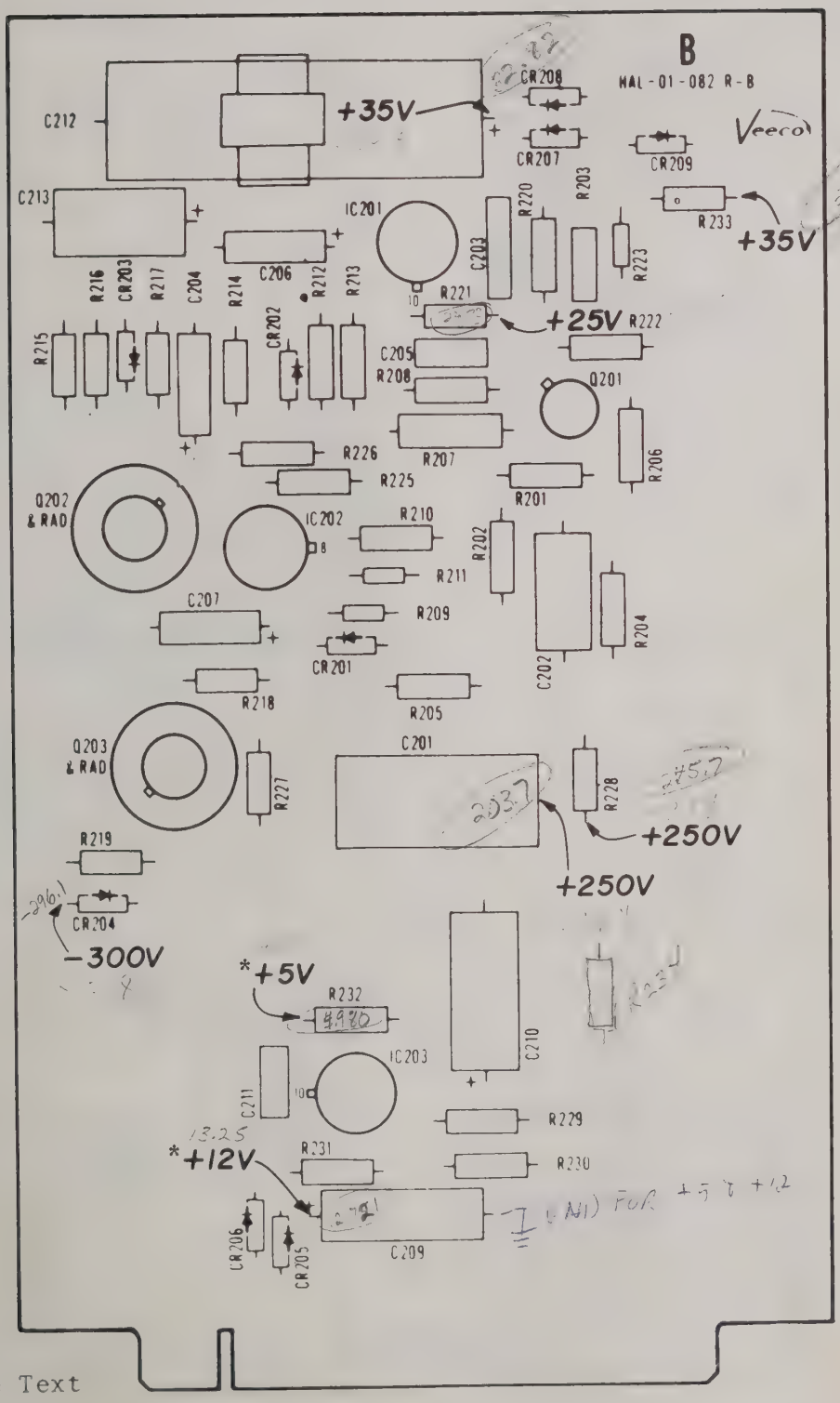
4. Board "E" (See Figure 26)

Board "E" is activated with the forepump circuit breaker "ON". Also the "A" board has to be plugged in its socket.

Measure the D.C. voltages, shown on the drawing relative to ground.

C. TROUBLESHOOTING - SYMPTOMS, CAUSES AND REMEDIES. (See Figures 20 and 21)

SYMPTOMS	CAUSE and/or REMEDY
Leak indicator meter reads high for a second or two when ELECTRONICS are first turned on.	Normal.
Leak indicator meter remains off scale on any scale and cannot be corrected with the ADJUST knob or COARSE BALANCE control.	Very large quantity of helium entering the Cee tube. Faulty "B" board Faulty COARSE ZERO Balance (leak indicator) Make sure all cable connectors are tight.
No Sensitivity	Burned out filament; switch to second filament; mis-turned; Make sure all cable connections are tight



*See Text

Figure 24. Circuit Board "B", Voltage Check Points

SYMPTOMS	CAUSE and/or REMEDY
High side background. ION VOLTAGE pot set very near one of its extremes. Test point AA (See Fig. 12) +300 Volts or more	Remove source and collector and abrade stain from vertex of tube. Clean with lint free rag and solvent, then heat to dry.
	Faulty COARSE ZERO BALANCE remote box Faulty CK5886 tube in collector end.
Leak indicator meter reads off scale down and cannot be corrected with the ADJUST knob or COARSE BALANCE control	Faulty circuit board "B"
EMISSION will not turn on, when starting up.	Pressure too high. Filament cuts off at 3 x 10^{-4} torr, but cuts back on at 1 x 10^{-4} torr. Emission too low - increase filament voltages.

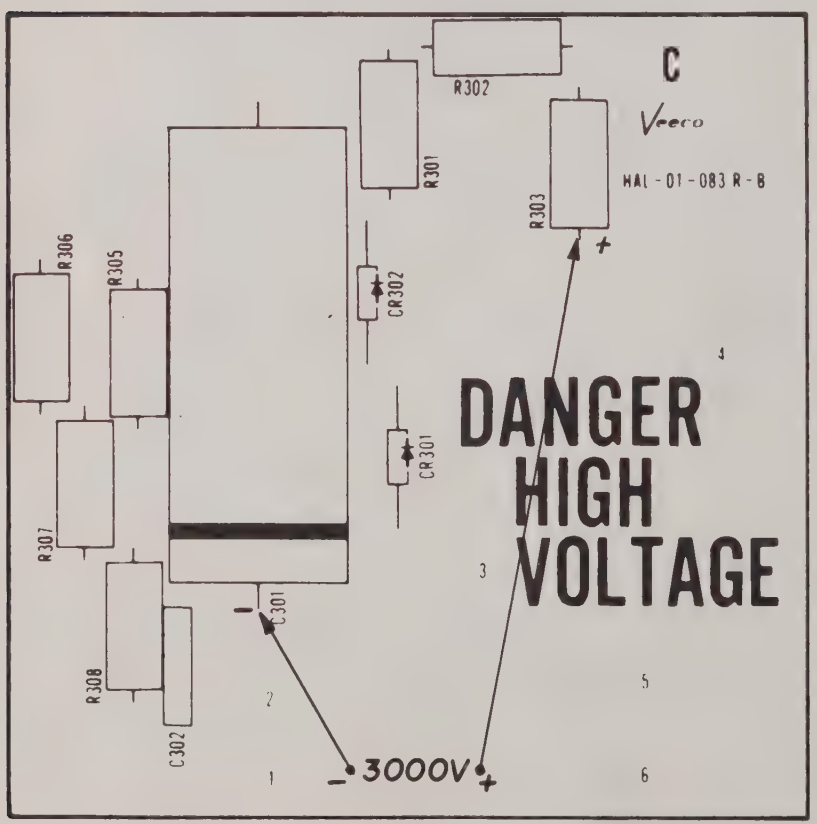


Figure 25. Circuit Board "C", Voltage Check Points

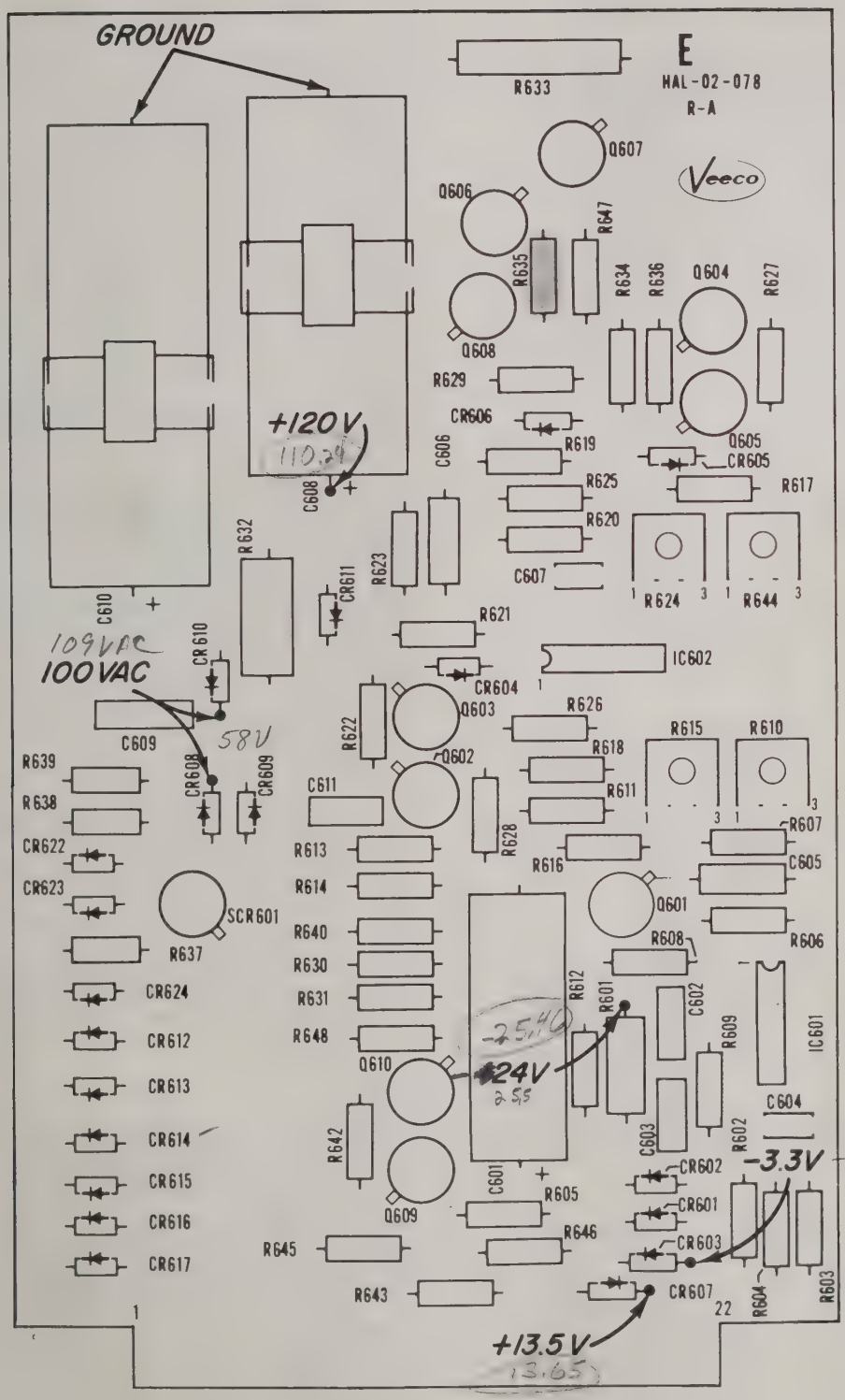


Figure 26. Circuit Board "E", Voltage Check Points

SYMPTOMS	CAUSE and/or REMEDY
Leak indicator meter erratic or pegs downscale.	Contaminated Discharge Gauge. (See cleaning procedure). Faulty T-3 transformer Faulty circuit board "C" Leaky high voltage cable; inspect Discharge Gauge component board (board "C") and blow clean with dry air. Faulty circuit board "A" Poor electrical ground. External causes such as sparking electrical equipment or large sources of R.F. energy nearby. Low line voltage. Contaminated plumbing.
Leak indicator meter fails to operate.	Meter not plugged into rear of cabinet. ELECTRONICS switch off. Faulty circuit board "A".
HI-VAC PRESSURE meter fails to operate.	Check High Voltage connector on flange of discharge gauge.

WARNING

TURN OFF ELECTRONICS; HIGH VOLTAGE PRESENT IN THIS CIRCUIT.

HI-VAC PRESSURE meter fails to operate. (Cont'd)

CAUTION

Turn off Electronics if this needs adjustment. Check circuit board "C" Check C301 for shorts. Check R302, R303 and R304. Faulty T3 high voltage transformer.

HI-VAC PRESSURE meter reads off scale, high.	High pressure due to leaks from atmosphere, outgassing of equipment attached to MS-17, high vapor pressure products from pump oils (such as water), or contaminants from decomposed diffusion pump oils. Diffusion Pump not turned on, or heater for diffusion pump not operating. Leaks may occur past "O" ring valve seals due to lint and similar foreign particles.

SYMPTOMS	CAUSE and/or REMEDY
HI-VAC PRESSURE meter erratic.	Contaminated Discharge Gauge, contaminated Vacuum System. See cleaning procedure. Faulty circuit board "C" Electrical shorts in high voltage or component board.
EMISSION meter fails to operate.	ELECTRON FOCUS improperly set. "Cee" tube filament open. Contacts on PRESSURE-EMISSION switch dirty or bent. Faulty circuit board "A"
MANIFOLD PRESSURE pegs up-scale	Open Pirani tube; dirty Discharge Gauge tube.
EMISSION meter reads low (below 1 mA).	ELECTRON FOCUS not properly adjusted. Faulty circuit board "A" Defective or weak filament, switch filament or replace.
EMISSION meter reads high (over 4 mA).	ELECTRON FOCUS not properly set. Faulty P.C. board "A" Check for short between points A & B of ion source. Remove source and clean area where filament is located. Also check electron focus potentiometer.
Leak meter fails to detune when HELIUM SCAN switch is moved to the HIGH position. Excessive background	Cee tube dirty; remove stain from vertex of spectrometer tube by physically abrading surface. Follow general cleaning procedure of the "Cee" tube.
Vent valve does not open after 1 sec. upon moving switch to VENT position	Open Solenoid coil. Faulty board "E"
Excessive pressure rise in high vacuum section when test valve opens.	Accumulation of dirt in Test Manifold. Vent valve leaking, due to dirt on seat. Remove and clean. Leak, or excessive outgassing from test piece or connection(s). MANIFOLD PRESSURE controller (test manifold) set too high.
Leak in test manifold.	Check especially side flange and top quick coupling openings.

SYMPTOMS	CAUSE and/or REMEDY
Vent valve leaking	Clean seat
Fluctuating helium signal slow recovery after closing calibrator. Poor ultimate pressure.	Check diffusion Pump. Check diffusion pump blower. Dirty discharge gauge, check cabinet air filters.
Frequent filament burnout	Crossover point on MANIFOLD PRESSURE Controller set too high. Reset crossover point. Check if high voltage lead to discharge gauge is connected properly. Continued operation at high pressures due to contaminated system. (10^{-4} and 10^{-5} torr scales.) Clean vacuum system and replace O-rings. Filament voltage set too high (check as per III, E, 1, a-h)
Solenoid Valves in "B" block fail to operate.	Check 2 Amp fuse in sub panel Check for operation of solenoid valves in electronics box Check diodes for open or short circuits on circuit board "E"
High pressire air burst to "Cee" tube when venting.	Leak past test valve seat. Disassemble, clean valve, giving giving special attention to removal of foreign material from "O" rings and "O" ring grooves. Vent solenoid valve in "B" block opens too soon, or test solenoid valve does not close soon enough.
Roughing pump breaker kicks off upon start-up.	Pump improperly shut down - run vented to atmosphere for at least one minute. Pump oil cold - run vented to atmosphere for at least one minute. Pump belt too tight.
Pump gurgling when backfilling port is vented, and/or pumping away fill gas as noted on pressure gauge for "C" block.	Solenoid valve in "C" Block fails to close properly. Disassemble and clean valve, giving special attention to removal of foreign material from "O" ring and "O" ring groove. "O" ring seal facing wrong way. It should be facing the pump.

SYMPTOMS	CAUSE and/or REMEDY
Roughing pump gurgles whenever Roughing or Test Valve is operated.	Normal, valves are vacuum operated and get their vacuum from the roughing pump.

D. INDICATIONS OF A CONTAMINATED VACUUM SYSTEM

1. HI-VAC Pressure Meter Off Scale

After approximately 25 minutes pump down time, the pressure meter should indicate less than 1 micron. If the pressure meter indicates above 1 micron it may be due to a contaminated system. High pressure readings may, however, be due to causes other than a contaminated system. These should be eliminated prior to suspecting contamination. They are:

a. Electrical short circuit in the discharge gauge cable or circuit

b. Loose mechanical pump belt, or greasy mechanical pump belt.

c. Diffusion pump oil and/or forepump oil badly contaminated.

d. Diffusion pump heater not operating.

e. Leak in the vacuum system.

f. Contaminated discharge gauge.

g. Liquid nitrogen trap recently run dry, permitting water to evaporate.

If Steps a to f check out properly it may be concluded that the system is contaminated. Contamination may have occurred due to the repeated connection of unclean objects to the test port, or from the backstreaming and subsequent deposit on the system walls of decomposition products from diffusion pump oil. Diffusion pump oil (Octoil in this case) will be decomposed if exposed to air while at operating temperature. If the oil has been decomposed (or "cracked") by air exposure, an acrid smell will be present at the mechanical pump exhaust.

When it has been established that contamination is the cause of the high pressure reading, the entire vacuum system should be cleaned, and a new charge of oil should be added to the diffusion pump and the mechanical pump as well.

2. Background

Another indication of a contaminated system is called "background." Background is caused by testing objects that are contamin-

ated with lubricating oils, etc., or by operation with a contaminated auxiliary set-up.

NOTE

Quite often the removal of background can be effected by warming the contaminated areas with a Veeco Degassing Gun while the system is pumping. This is the simplest method and should be tried before disassembly of vacuum plumbing.

The HELIUM SCAN switch located on the main panel is provided in order to determine the decrease in signal ±30 Volts either side of the helium peak. Holding the switch up to HIGH (voltage) (with helium entering the Cee tube) should cause the leak indicator meter to decrease; if it remains about the same or increases, then low-side background exists. Likewise, if the meter rises when the switch is held down to LOW (voltage), high-side background exists.

If "background" exists, that tends to obscure the true helium peak, the sensitivity of the detector is impaired and the situation should be corrected immediately by cleaning the contaminated sections. (Refer to general remarks on cleaning procedure.)

3. Location of Contaminated Sections

a. Isolate objects to be tested, and/or auxiliary set-ups from the MS-17; plug the ports and place in TEST condition.

b. If background remains, after step a, close the THROTTLE VALVE. If the background disappears, then the vacuum lines from the THROTTLE VALVE to the ports, the test valve, vent valve and/or the oil in the roughing pump should be suspected as the source of the contamination.

c. If background remains after step b, turn off the ELECTRONICS, turn off the DIFFUSION PUMP, remove the source cable and allow 10 to 15 minutes for the diffusion pump to cool. Vent the system (through the THROTTLE VALVE) drain and flush the forepump with clean Duo-Seal Oil, fill forepump to proper level and start up system according to normal operating procedures. Replace source cable after "Cee" tube has been evacuated.

d. Finally, if background still remains, the system should be shut down again and the diffusion pump, "Cee" tube, and cold trap thoroughly cleaned.

E. CLEANING PROCEDURES (See Figure 27)

1. General

a. In the event a vacuum system becomes contaminated by high vapor pressure materials, not easily removed by pumping and mild baking, it is necessary to disassemble and clean all component parts affected.

b. Many organizations have established cleaning procedures for vacuum apparatus, such as electron tube parts, test chambers, etc. These methods will normally be appropriate for cleaning the mass spectrometer system.

c. Although metal and glass sections may be placed in a hot vapor degreaser as a first-step cleaning procedure, this is not recommended unless great care is taken to insure proper hot vapor degreasing techniques, and the use of solvents that will not further contaminate the part being cleaned.

d. Internal surfaces that can be reached with clean cloth swabs should be physically swabbed out, using a minimum of degreasing solvent on the swab. Internal portions of the system that cannot be reached must be flushed with enough solvent to allow all surfaces to be wet, and as much physical action employed (shaking and sloshing) as practicable.

e. Synthetic rubber "O" rings (usually Neoprene) are susceptible to absorbing large quantities of the solvents used in cleaning, the subsequent evaporation of these solvents when a system is evacuated must be avoided, therefore "O" rings and gaskets should be removed from the flange grooves and treated as a separate cleaning problem. "O" rings and gaskets are either replaced at the time of reassembly (and this is recommended), or carefully wiped clean with a lint-free material, and inspected for surface damage of any kind before they are used again. If new rings are used, they should be wiped, inspected and lubricated in the same manner as used rings.

NOTE

Never remove "O" rings with a metal tool, as this will invariably scratch the "O" ring groove, causing a potential - if not actual - leak. Use plastic (e.g., corner of a plastic badge, etc.) or wood (e.g., toothpick, etc), and remove "O" ring by inserting tool between outside of "O" ring and groove, and sliding around "O" ring. This will cause "O" ring to "pop up" ("O") ring may have to be held on opposite side to prevent turning in groove), and generally gives better results than trying to "pry" the "O" ring from the groove.

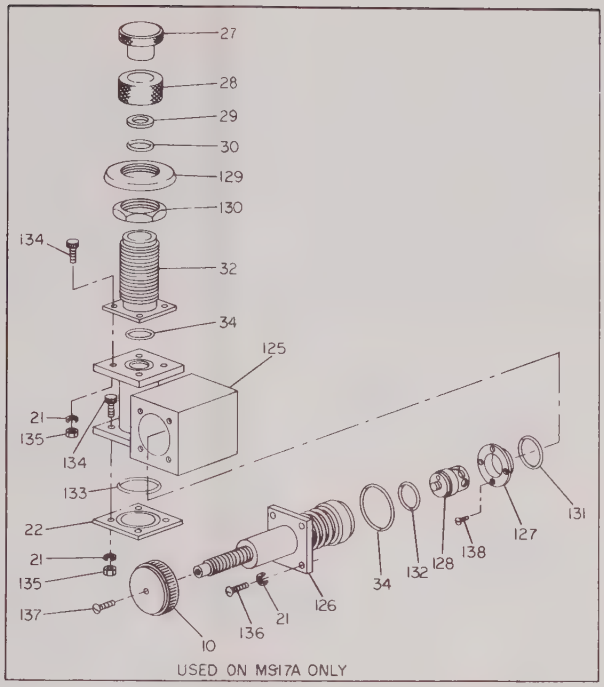
ITEM	IDENTIFICATION	PART NO.
1	SCREW, PAN HD, NO. 6-32 X 1-5/8	COML
2	CYLINDER ROUGHING	0126-049
3	ELBOW	1620-727
4	"O' RING	0011-340
5	STEM NUT	0126-042
6	' O" RING	0011-015
7	PISTON	0126-041
8**	TRUARC RING INT.	1330-722
9	SCREW, CTSK, OVAL-HD, NO. 10-32X1/2	COML
10	KNOB	1320-057
11**	STEM GUIDE	0126-077
12**	SPRING	1330-721
13	COLLAR	0126-043
14	SCREW, SOC.-HD, NO. 6-32X1/2	COML
15	LOCKWASHER, SPLIT, NO. 6	COML
16	SCREW, FLT-HD, NO. 1/4-20X5/8	COML
17**	STEM, CAP AND BELLOWS ASSEMBLY	0126-047
18	"O" RING	0011-113
19**	"O'RING	0011-217
20	SCREW, SOC-HD, NO. 10-32X5/8	COML
21	LOCKWASHER, SPLIT NO. 10	COML
22	BLANK FLANGE	0126-078
23	'O' RING	0011-222
24*	' O" RING	0011-225
25	VALVE BLOCK	0126-026
26	THROTTLE STEM	0126-044
27	BLANK PLUG	0103-317
28	Q.C. NUT	0103-313
29	Q.C. WASHER	3140-003
30	' O" RING	0011-216
31	MOUNTING RING	0126-235
32	TEST PORT ASSEMBLY	0126-075
33	SCREW, SOC-HD, NO. 10-32X3/4	COML
34*	"O" RING	0011-223
35	PIRANI TUBE ASSEMBLY	5600-020 or 100***
36	ELBOW	1620-740
37	VENT VALVE ASSEMBLY	0119-067
38	NIPPLE	1620-749
39	MICRON FILTER	1890-015
40	CYLINDER TEST	0126-040
41 }	DIFF. PUMP AND FAN ASSEMBLY - 115. OR	0126-024-01
42 }	DIFF. PUMP AND FAN ASSEMBLY - 230 V	OR 0126-024-02
43	SCREW, SOC-HD, 1/4-20X1-5/8	COML
44	LOCKWASHER, SPLIT, 1/4	COML
45	ACCUMULATOR VALVE	0126-008
46	ACTUATOR ROD	0126-120
47	COTTER PIN	1330-745
48	WASHER, FLAT NO. 10	COML
49	COLD TRAP ASSEMBLY	0126-050
50	"O" RING	0011-016
51	MODIFIED DG 3 ASSEMBLY	0120-244
52	"O" RING	0011-220
53	' O" RING	0011-224
54	CEE TUBE ASSEMBLY - MS-17 SERIES	0126-065
55	ROUGH MANIFOLD ASSEMBLY	0126-073
56	CLAMP (LARGE)	1330-035
57	HOSE CONN., ROUGHING	1750-011
58	HOSE CONN., ROUGHING	1750-012
59	CEE TUBE SPACER	0126-219
60	BOLT, HEX-HD, NO. 1/2-20X7/8	COML
61	WASHER, FLAT, 1/4	COML
62	NUT, HEX, 1/4-20	COML
63	FORELINE MANIFOLD ASSEMBLY	0126-139
64	HOSE CONN., FORELINE	1750-004
65	CLAMP	1330-034
66	REF. BUCKET ASSEMBLY	0126-060
67	FORE PUMP ASSEMBLY 60C	0126-097-01
68	FORE PUMP ASSEMBLY 50C	0126-097-02
69	BOLT, HEX HD., 5/16-18X3/4	COML
70	LOCKWASHER, SPLIT 5/16	COML

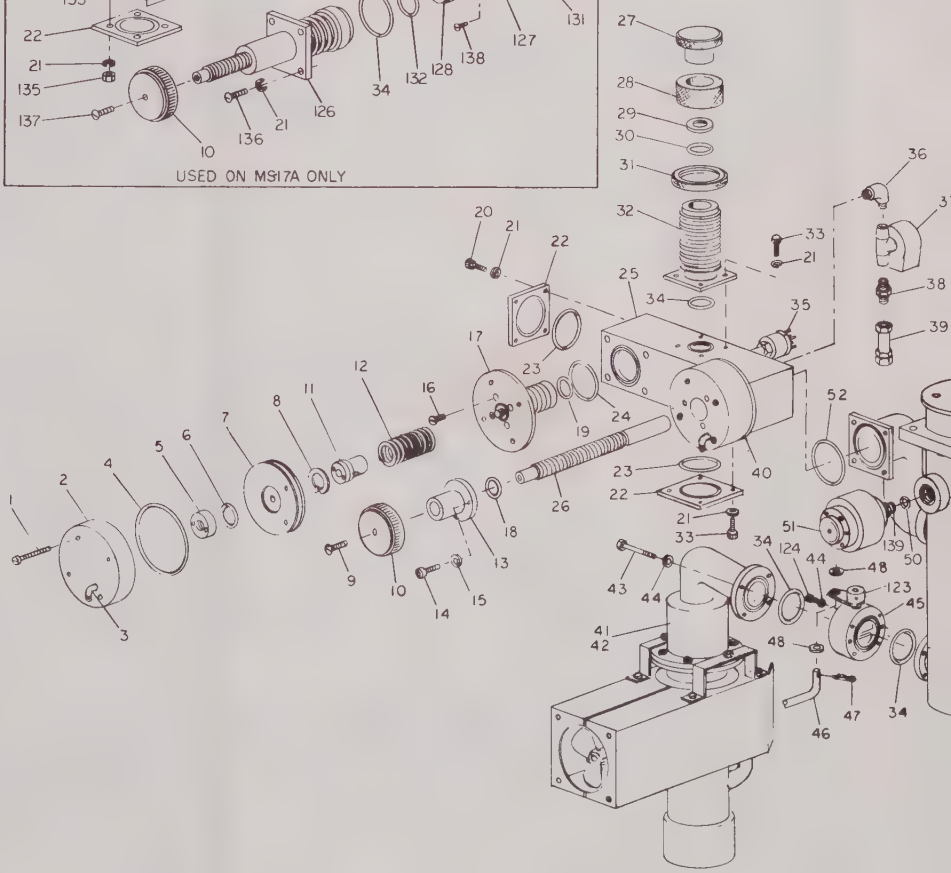
ITEM	IDENTIFICATION
71	WASHER, FLAT, 5/16
72	DIFF. PUMP SUPPORT
73	SUPPORT CLAMP
74	BOLT, HEX-HD, 1/4-20X
75	TERMINAL STRIP
76	SCREW, PAN-HD, NO. 10
77	SHIELD ASSEMBLY
78	SCREW, PAN HD., NO. 8
79	WASHER, FLAT, NO. 8
80	LOCK WASHER, SPLIT, N
81	10 CFM PUMP, 115V. 60C
82	5 CFM PUMP, 115 V 60C
83	10 CFM PUMP, 230V, 50C
84	5 CFM PUMP, 230V, 50C
85	10 CFM PUMP, 115V, 50C
86	5 CFM PUMP, 115V, 50C
87	CABINET FRAME
88	BALLAST ADAPTOR
89	VIBRATION MOUNT
90	PLATE
91	MALE ELL 90° 1/4 MPT
92	CHECK VALVE
93	CONNECTOR
94	1376 PUMP BASE MOD
95	VEE BELT
96	VEE BELT
97	BOLT, HEX-HD., 1/4-20X
98	MOTOR, 115/230V, 50 CY
99	MOTOR, 115/230V, 60 CY
100	MOTOR, 115/230V, 50CYC
101	MOTOR, 115/230V, 60 CY
102	PULLEY
103	PULLEY
104	1402 MECH. PUMP
105	MECH. PUMP 10 CFM (13
106	VEE BELT
107	VEE BELT
108	1/3 HP MOTOR, 60 HZ
109	1/3 HP MOTOR, 50 HZ, 11
110	1/3 HP MOTOR, 50 HZ, 23
111	PULLEY
112	PULLEY
113	SCREW, FLT-HD, 1/4-20X
114	ELASTIC LOCKNUT, 1/4-2
115	1400 PUMP BASE
116	BOLT, HEX HD, 5/16-18X
117	1400 PUMP
118	1400 PUMP MTG. BRACKE
119	BOLT, HEX-HD, 5/16-18X
120	ELASTIC LOCKNUT, 5/16-
121	TERMINAL BLOCK ASSEM
122	BRACKET, BARRIER STRI
123	ACCUMULATOR VALVE A
124	BOLT, HEX-HD., 1/4-20X
125	THROTTLE VALVE BRAZ
126	STEM, CAP AND BELLOW
127****	VALVE SEAT
128****	THROTTLE GATE
129	MOUNTING RING
130	MOUNTING NUT
131****	"O" RING
132****	"O" RING
133	"O" RING
134	SCREW, SOC.-HD., NO. 1
135	NUT, HEX, NO. 10-32
136	SCREW, RD.-HD., NO. 10
137	SCREW, FLT.-HD., OVAL
138	SCREW, FLT.-HD., NO. 3
139	NIPPLE AND FLANGE ASS

* Sold in sets of 5 (Part No. 0126-811)
** Sold as a complete subassembly - Replacer
*** See Section 5
**** Sold as part of rebuilding kit (Part No. 0

Figure 27. MS-17AB Exploded View

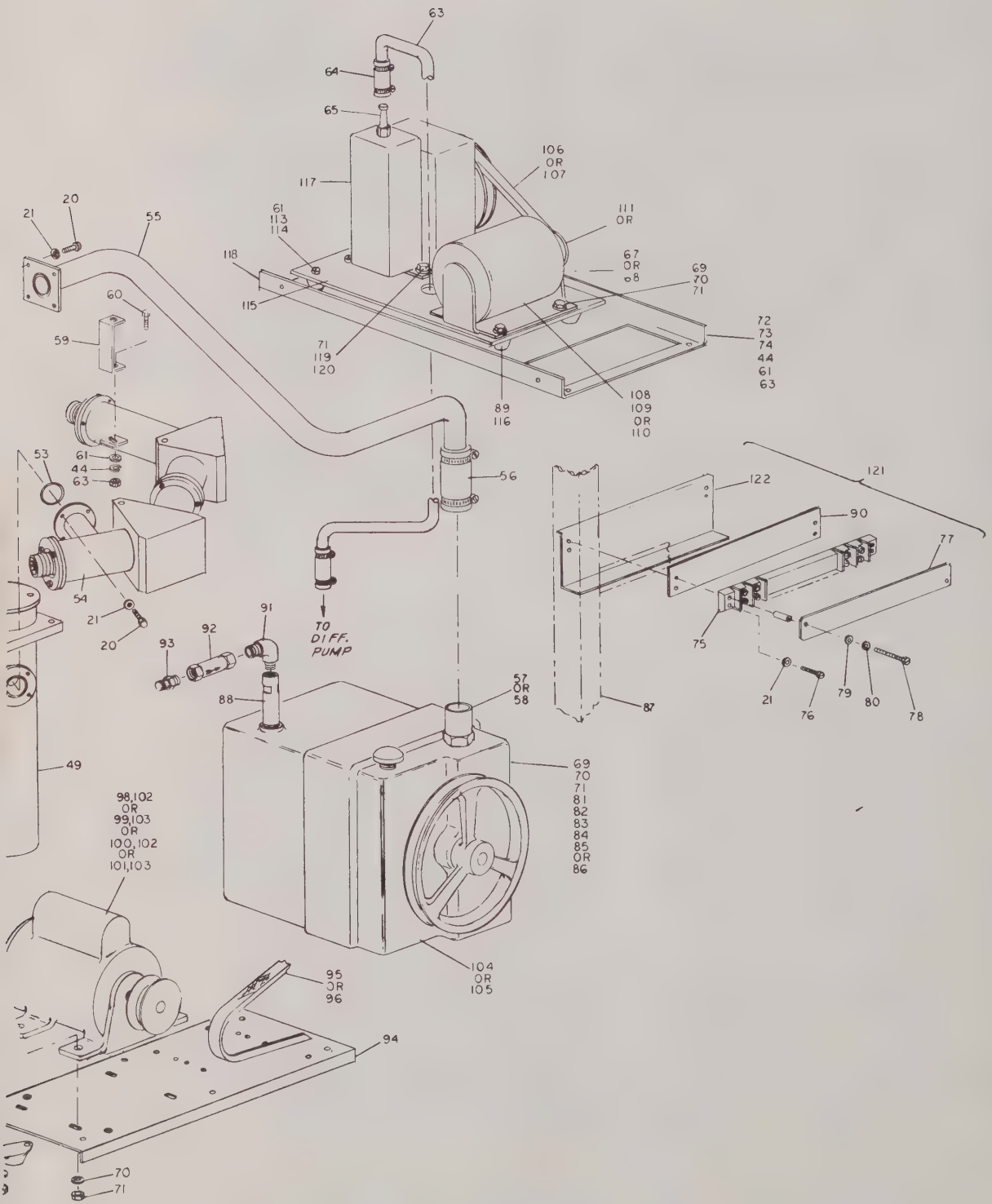
	PART NO.
	COML
	0126-123
	0126-124
/2	COML
	1840-052
X3/4	COML
	0126-183
X1-1/2	COML
	COML
8	COML
	0126-064-01
	0126-064-02
	0126-064-03
	0126-064-04
	0126-064-05
	0126-064-06
	0126-010
	0126-099
	1330-479
	0126-443
	1620-740
	1890-075
	1620-702
	0126-021
	1680-033
	1920-009
4	COML
	1180-057
	1180-058
	1180-063
	1180-090
	1920-024
	1920-023
	1660-034
	1670-001
	1920-006
	1920-008
	1180-055
Y	1180-056
	1180-054
	1330-043
	1330-041
8	COML
	COML
	0126-096
3	COML
	1670-017
	0126-095
3	COML
	COML
LY	0126-443
	0126-439
UATOR	0126-127
5/8	COML
	0126-211
ASSY	0126-217
	0103-269
	0103-275
	0103-315
	0103-316
	0011-116
	0011-212
	0011-219
32X7/8	COML
	COML
2X5 8	COML
NO. 10-32X1/2	COML
6X11/32	COML
	0126-247





nt Stem and Bellows (Part No. 0126-810)

6-813)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PUMP
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The solvents referred to in this section are Freon, trichloroethylene and acetone. Trichloroethylene is used where large deposits of grease and oil are to be removed. Acetone is preferred over trichloroethylene although precautions must be taken in either case. The inhalation of the vapors must be avoided, particularly in the case of trichloroethylene, and the flammable nature of acetone presents an added hazard. Other cleaning agents such as soaps, alkali cleansers, and synthetic detergents may be used as first-step cleaners providing complete facilities for thorough rinsing with hot distilled water are available.

Heating components, before reassembly, should be considered as part of the final cleaning and is easily accomplished by a hot air stream from a Veeco Degassing Gun.

f. After cleaning, reassemble the pump taking care that the ejector stage lines up the forearm when replacing the Jet Stack into the body. A locating pin in the pump bottom will assure this lineup.

g. Refill pump with 120 cc's of Octoil. Do not use any substitute or degradation of the spectrometer will result.

NOTE

Fresh pump fluid gives off large quantities of gas when first exposed to low pressures causing system pressure to rise. Pressure rises of this type should not be mistaken for an indication of leakage.

2. Mechanical Pumps, Cleaning (See Figures 27 and 20)

Mechanical pumps often become contaminated with large amounts of water and/or decomposition products from the oil diffusion pump.

a. To change oil, disconnect the pump from the system. Warm the oil by operating the pump with the intake closed, for approximately 15 minutes. Stop the pump and remove the oil drain cap. Most of the oil will drain out freely.

WARNING

Oil will be hot! The small residue remaining in the pump can be forced out by turning the pump pulley by hand, with the exhaust port closed and intake open. The oil will spurt out suddenly and should be deflected into the drain pan.

CAUTION

Extensive operation with the exhaust port sealed should be avoided, as excessive internal pressure may loosen the shaft seal.

b. After removing all oil, close the drain and pour 3 or 4 ounces of clean Duo-Seal Oil into the intake port. Open exhaust port and run pump for a short period to completely circulate the new oil. Drain the flushing oil and force out residue, as above. Repeat flushing with new Duo-Seal Oil until flushing oil remains clean and free of color and foreign matter.

CAUTION

Do not use solvents or light flushing oils. Their complete removal is difficult and their higher vapor pressures will prevent the attainment of high vacuum.

c. After the pump is completely flushed, refill by pouring new Duo-Seal Oil into the exhaust port. Fill to proper level indicated on the sight glass. Replace dust cap. A gurgling noise is characteristic when high pressure air is drawn through the pump. It should disappear quickly as the intake pressure is reduced. If the pump continues to gurgle, the oil level may be too low. Insufficient oil does not give proper sealing or lubrication. Add oil through the exhaust port until it reaches the proper level. The oil level should be maintained between the marks on the sight glass, with the pump running. Level will drop when pump is stopped.

F. DISASSEMBLY OF THE VACUUM SYSTEM. (See Figure 28)

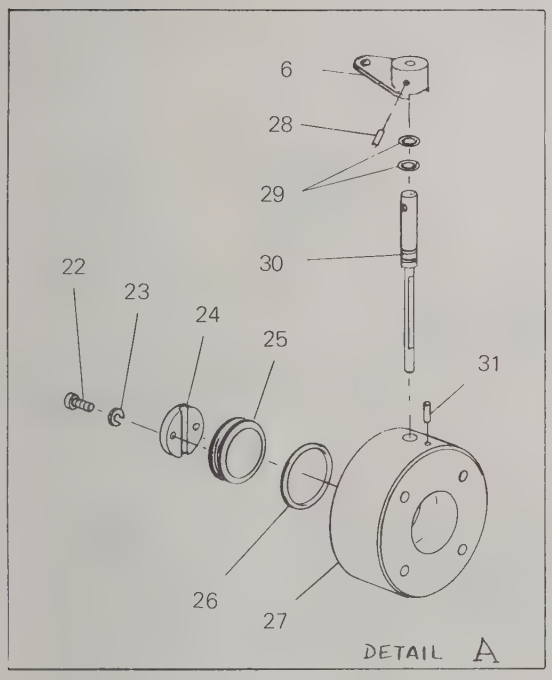
Each unit of the vacuum system, with the exception of the mechanical pump, is joined to its adjacent unit by either flanges or quick couplings. The flanges are sealed by Neoprene "O" rings or Teflon gaskets. The vacuum system may be easily disassembled, allowing inspection and cleaning of all component parts. When the system is to be disassembled for cleaning remove cold trap bucket, decant the liquid nitrogen, and dry bucket thoroughly before replacing. Use of a Veeco degassing Gun will greatly facilitate the drying process.

1. Cee Tube (See Figures 29 and 30)

Follow the operating procedures for admitting air to the Cee tube. The Cee tube contains the source Assembly and the collector Assembly. The magnets are external and can be removed without disturbing the vacuum system. The polarity of the magnets is stamped. The (S) should face the floor.

ITEM	IDENTIFICATION	PART NO.
1	SCREW, SOC.-HD., 1/4-20X1-5/8	COML
2	LOCKWASHER, SPLIT, 1/4	COML
3	DP TO VALVE ASSY	0126-082
4	"O" RING	0011-223
5	WASHER, FLAT, NO. 10	COML
6	ACCUMULATOR VALVE ACTUATOR	0126-127
7	ACCUMULATOR VALVE	0126-008
8	ACTUATOR ROD	0126-0120
9	COTTER PIN	1330-745
10	SCREW, FLT.-HD., NO. 10-32X1/2	COML
11	CT TOP FLANGE	0126-086
12	"O" RING	0011-245
13	COLD TRAP ASSY	0126-050
14	"O" RING	0011-237
15	DIFFUSION PUMP ASSY 115V OR 230V	4530-001-01 OR -02
16	LOCKWASHER, SPLIT 1/4	COML
17	NUT, HEX-HD., 1/4-20	COML
18	SCREW, HEX-HD., 1/4-20X1-1/4	COML
19	WASHER, FLAT, 1/4	COML
20	RH FAN HOUSING ASSY, 115V	4530-021-01
21	RH FAN HOUSING ASSY, 230V	4530-021-02
22	SCREW, BDG.-HD., NO. 4-40X5/16	COML
23	LOCKWASHER, NO. 4	COML
24	CLAMPING DISC	2830-014
25	FLAPPER	2830-013
26 *	"O" RING	0011-214
27	FLANGE	2830 011
28	DRIV-LOK PIN	1330-724
29 *	"O" RING	0011-009
30	SHAFT	2830-012
31	DRIV-LOK PIN	1330 723
32	SCREW, SOC.-HD., 10/32X7/8	COML
33		

* Sold in sets of 5 (Part No. 0126-812)



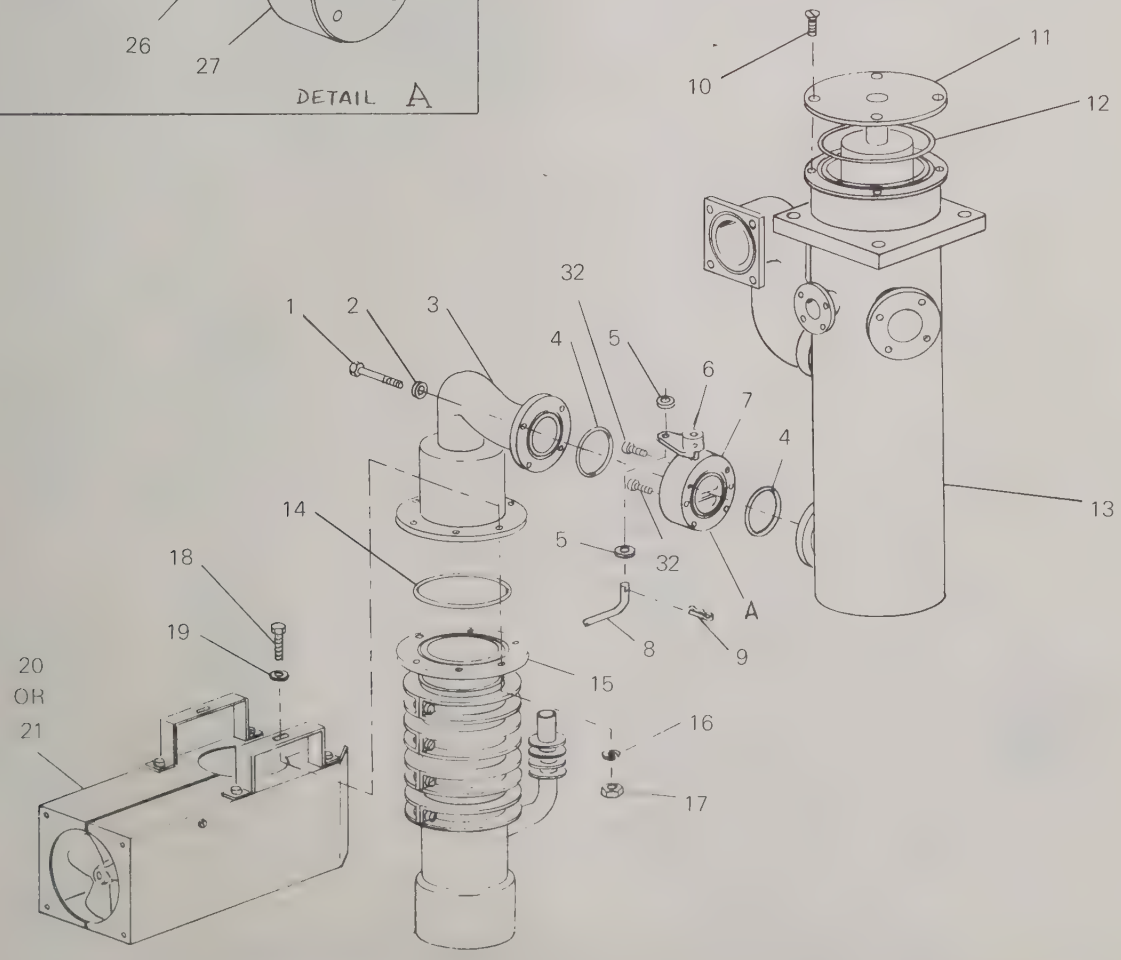
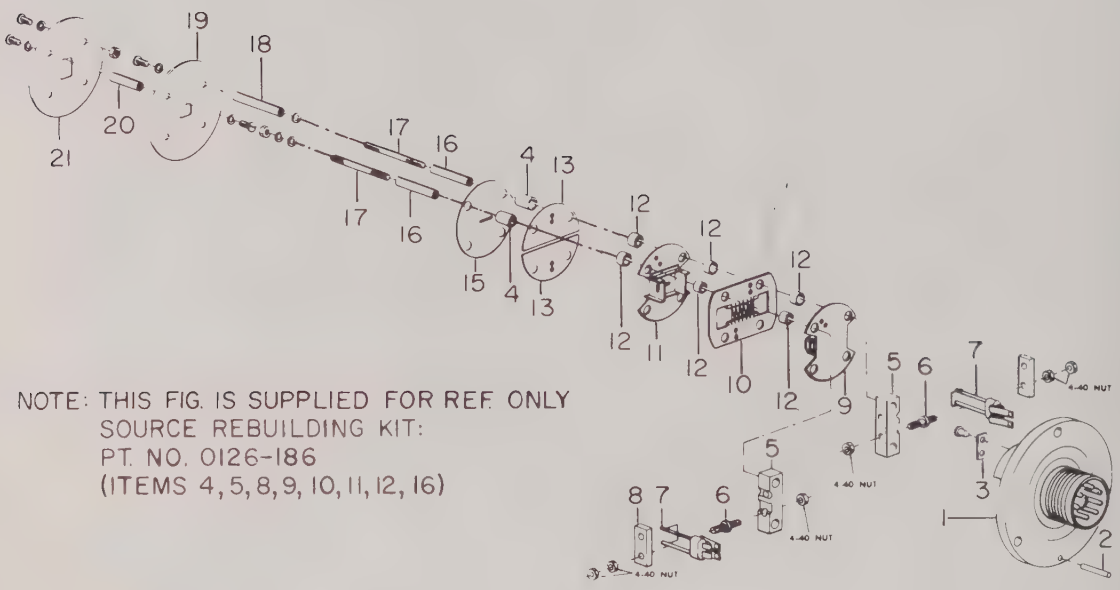
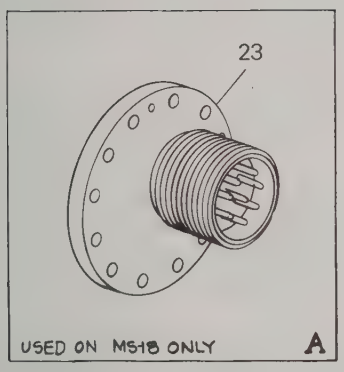


Figure 28. MS-17 High Vacuum Assembly, Exploded View



Ref	Description	Part Number
1.	Flange Assy.	0103-134
2.	Locating Pin	1330-226
3.	Ground Lug	0103-138
4.	Spacer	0103-125
5.	Filament Mounting Block	0103-145
6.	Filament Mounting Stud	0103-147
7.	Filament (Box of 5)	0103-141-01
8.	Clamping Block	0103-146
9.	Electron Focus Plate	0120-057
10.	Repeller Grid Assy.	0120-284
11.	Shield Assy.	0120-055
12.	Spacer	0103-124
13.	Ion Focus Plate	0103-154
15.	Object Plate	0103-118
16.	Insulator	0103-126
17.	Stud	0103-122
18.	Baffle Post	0103-127
19.	Lower Baffle	0103-119
20.	Baffle Post	0103-128
21.	Upper Baffle	0103-121

Figure 29. Cee Tube Source, Exploded View



ITEM	IDENTIFICATION	PART NO.
1	SCREW, PAN-HD., NO. 2-56X3/16	COML
2	WASHER, LOCK, NO. 2	COML
3	UPPER BAFFLE	0103-187
4	NUT, HEX, NO. 2-56	COML
5	BAFFLE POST	0103-128
6	LOWER BAFFLE	0103-186
7	BAFFLE POST	0103-127
8	WASHER, FLAT, NO. 2	COML
9	INSULATOR	0103-123
10	INSULATOR	0103-123
11	SLIT PLATE	0103-181
12	SPACER	0103-124
13	SUPPRESSOR PLATE ASSY	0103-188
14	GROUND PLATE ASSY	0103-189
15	TARGET SUPPORT ASSY	0103-202
16	STUD	0103-182
17	COLLECTOR POST	0110-068
18	GROUND PLATE TUBING	0126-137
19	LUG AND WIRE ASSY	0103-173
20 *	RESISTOR, 1000K MEG OHM ±10%	1720-924
21	HAT ASSY	0126-130
22	COLLECTOR RECEPTACLE AND MTG. ASSY	0126-176
23	COLLECTOR RECEPTACLE AND MTG. ASSY	0126-114
24	LUG AND WIRE ASSY	0103-172
25 *	ELECTRON TUBE	1850-031

* Sold in a set as Kit Part No. 0126-228

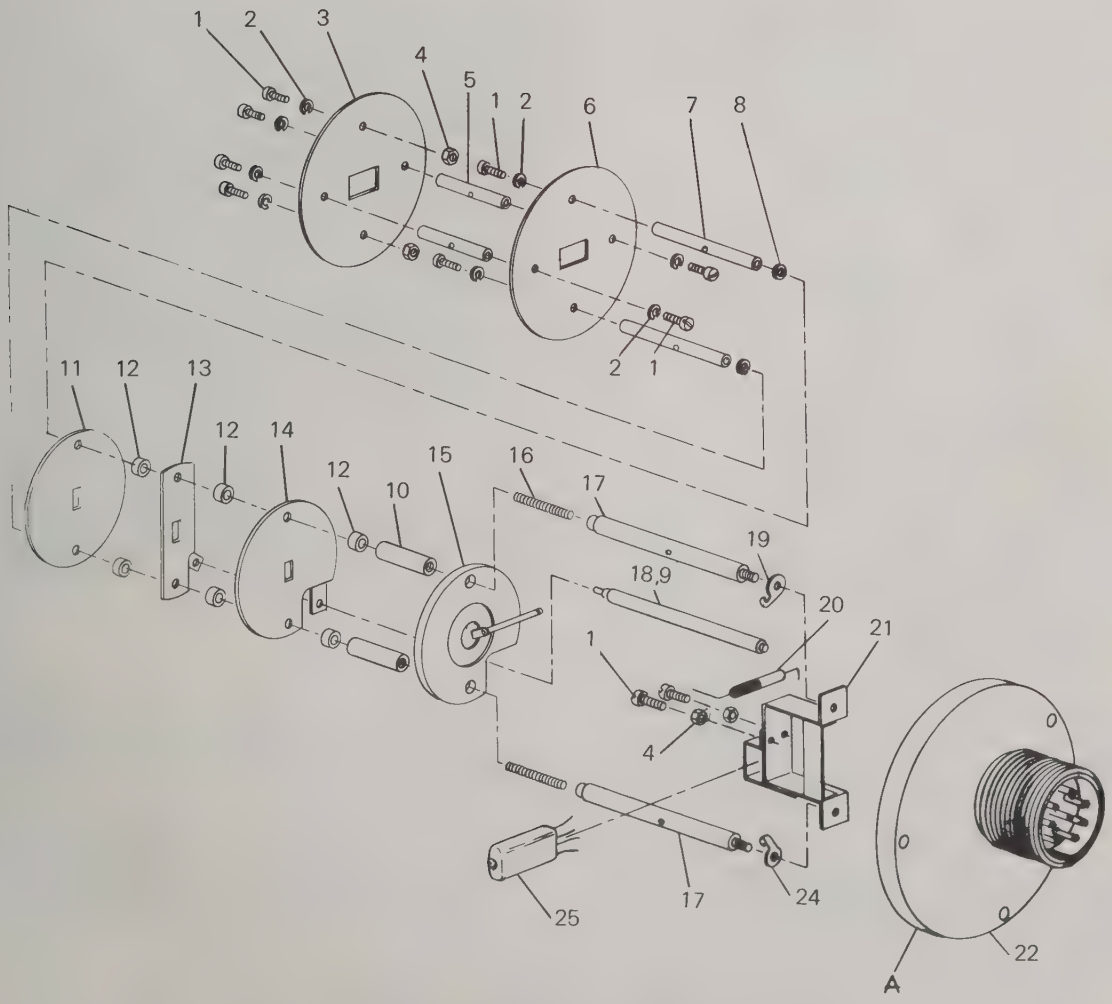


Figure 30. Cee Tube Collector, Exploded View

2. Diffusion Pump (See Figure 31)

The fractionating oil diffusion pump used in the MS-17 series is a modified Veeco type. This pump can be readily disassembled for cleaning as follows:

a. Remove left side panel, unplug the fan and diffusion pump

b. Remove the two hex bolts holding the fan assembly to the diffusion pump. Remove the two binding head screws on the side of the fan box and the two halves of the fan assembly can be taken out of the machine.

c. After the pump has been removed from the system and the hold down spider and spring removed, the jet assembly may be removed and the oil drained from the pump

d. All inside surfaces of the pump which show tar may be thoroughly cleaned with a solvent such as acetone or trichloroethylene and a stiff brush. Occasional difficult spots may be rubbed clean with a fine grade of emery cloth such as Carborundum No. 360A silicon carbide cloth. Be careful to flush all traces of emery away with solvent and blow the pump out with clean hot, dry air.

e. If desirable, the jet stack may be completely disassembled to facilitate cleaning.

f. When reassembling be sure all jets fit together correctly and each stage "bottoms" against the shoulder of the mating part.

3. Cold Trap

The cold trap bucket surfaces that are exposed to the vacuum system should be kept as clean and dry as possible. Make sure that "O" ring is clean and lightly greased and placed in the groove properly when replacing the cold trap bucket.

4. Valves

There are holes in the bonnet (top flange) of the roughing and the Test Valve, which allow leak testing of the bellows without removing it from the valve body. If a bellows assembly develops a leak, it should be replaced (P/N 0126-810).

The valve bellows assemblies may be removed from the vacuum system for inspection and cleaning. Follow operating procedures for admitting air to the section of the vacuum system desired.

CAUTION

Never extend a bellows assembly that is not assembled within a valve body. This may stretch the bellows beyond a critical point, and drastically reduce its life.

ITEM	IDENTIFICATION	PART NO.
1	FLANGE, MOD	0126-084
2	ELBOW, MOD	0126-083
3	ELBOW, 90°	1620-063
4	REDUCING COUPLING	1620-210
5	FLANGE, PLAIN	3670-002
6	SET SCREW	1330-798
7	RETAINER ASSY	4530-059
8 *	SPRING	1330-799
9 *	TOP CAP	4530-030
10 *	TOP JET	4530-032
11 *	MIDDLE JET	4530-034
12 *	BOTTOM JET ASSY	4530-044
13	DP WELDMENT	4530-011
14	SCREW, PAN-HD., NO. 10-32X3/4	COML
15 *	BAFFLE ASSY	4530-018
16	LOCKWASHER, SPLIT, 1/4	COML
17	NUT, HEX, 1/4-20	COML
18	COOLING FIN	4530-050
19	NUT, SQUARE, NO. 10-32	COML
20	NUT, HEX, REG, 1/4-20	COML
21	CORD CLAMP	1650-095
22	WASHER	1330-727
23	NUT, HEX, JAM, 1/4-20	COML
24	HEATER 115V OR 230V	1180-045 OR -223
25	MOD WASHER	4530-027
26	FAN HOUSING WELDMENT	4530-012
27	SCREW, HEX-HD., 1/4-20X1-1/4	COML
28	WASHER, FLAT, 1/4	COML
29	MUFFIN FAN, 115V OR 230V	1180-129 OR 130
30	SCREW, PAN-HD., NO. 6-32X1-3/4	COML
31	LOCKWASHER, SPLIT, NO. 10	COML
32	SCREW, MACH., PAN-HD., NO. 10-32X3/8	COML
33	RH FAN HOUSING ASSY, 115V	4530-021-01
34	RH FAN HOUSING ASSY, 230V	4530-021-02
35	DIFF PUMP ASSY, 115V	4530-001-01
36	DIFF PUMP ASSY, 230V	4530-001-02
37	D.P. CABLE ASSY	4530-020
38	LOCKWASHER, SPLIT, NO. 6	COML

* Available as D.P. Jet Stack Kit Part No. 4530-010

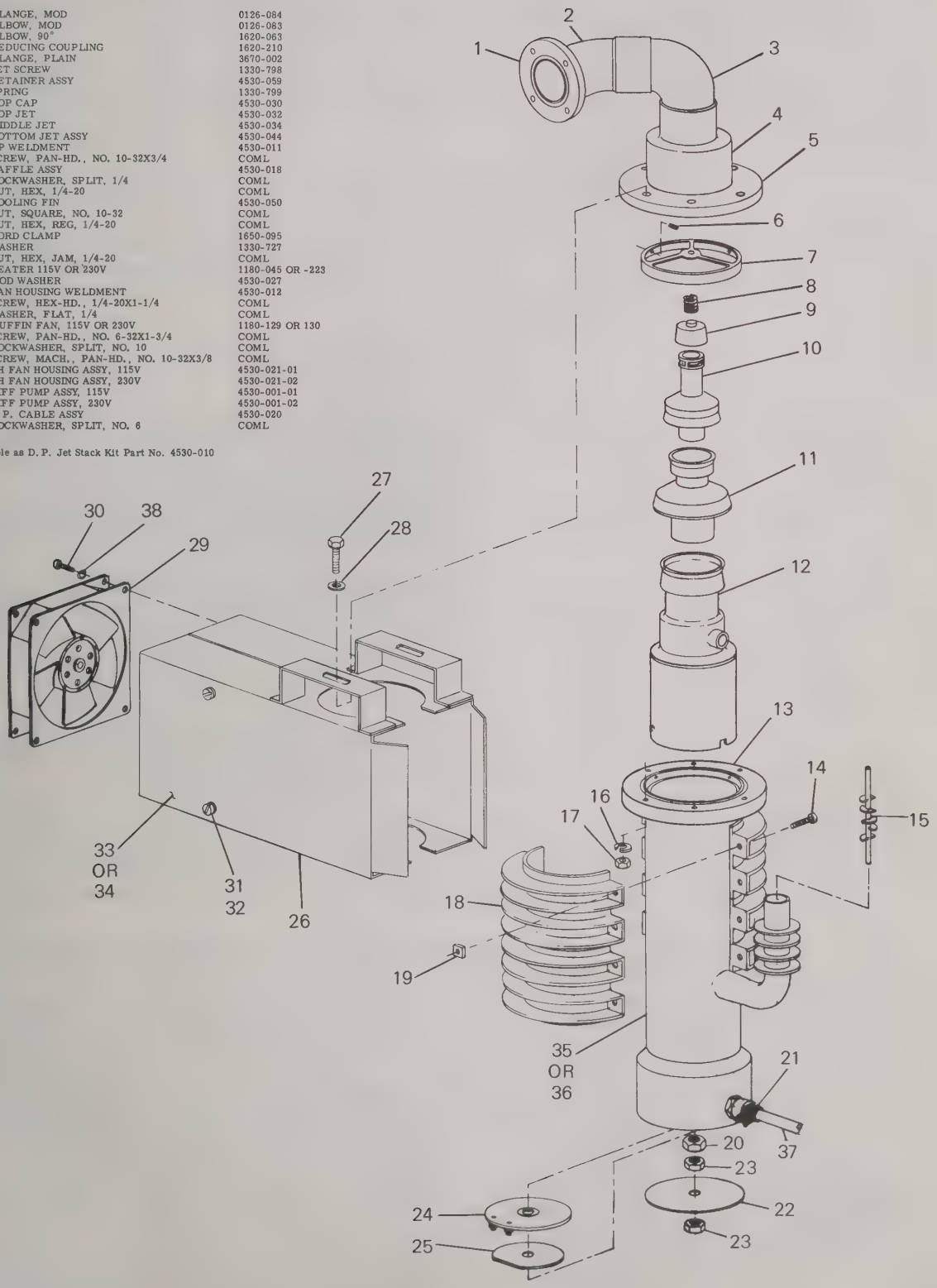


Figure 31. Diffusion Pump, Exploded View

If the entire vacuum system is being cleaned, new Neoprene "O" rings should be used.

To remove either the Roughing or the test valve for replacement or cleaning, shut down the system, vent completely and proceed as follows:

a. Remove the throttle valve handle and the panel behind it (held in place by 4 screws)

b. Shut off the roughing pump, and remove the plastic hose from the respective valve you are servicing. A threaded bushing and plastic ferrule hold this hose on and vacuum tight.

c. Remove the 4 screws in the vacuum operator and carefully pull off the cover.

d. Remove the piston using the tool provided to loosen the center nut.

e. Loosen the 4 flat head screws holding the bellows assembly in place and remove.

f. All lint and foreign material must be removed from the manifold block and "O" rings. Special attention should be given to the "O" rings. Make sure they are wiped clean with a lint free cloth, and regreased with a minimum of grease.

g. When reassembling, clean and regrease liberally the vacuum actuator piston "O" ring and the walls of the cover with Versilube grease (P/N 1990-050).

5. Solenoid Vent Valve (on test manifold) And (2) Vacuum Actuators (Contained In Electronics Cabinet Behind Main Panel).

To service the solenoid valves:

a. Remove the Coil Assy - either by popping the red plastic retaining clip on top or by loosening the nut.

b. The Solenoid Base Assembly may now be loosened and re-removed along with the Plunger assembly.

c. Clean out the body and the plunger before reassembly. Be sure the "O" rings and plunger discs are clean and regreased using a minimum of high vacuum grease.

6. Accumulator Valve (Located between the Cold Trap and the Diffusion Pump Manifold) (See Figure 28)

a. Remove the linkage and four bolts which holds the diffusion pump manifold to the cold trap. Remove diffusion pump support bracket and lower diffusion pump out of the way. Remove two bolts holding valve to cold trap. Remove accumulator valve from cabinet.

b. The flapper plate may now be taken out of the valve body to be cleaned and regreased.

c. When reassembling, close the valve and center the flapper in the body before tightening the flapper mounting screws.

G. BLOWERS AND FILTERS

There are 3 blowers in the MS-17. They should be oiled periodically as indicated in the maintenance schedule.

1. Cabinet Blower. (Located on the rear panel. For ventilating the cabinet).

2. Diffusion Pump Blower. (Mounted in position to cool the diffusion pump fins.)

3. Source Blower. (Located just below the source for cooling the source flange).

The Cabinet Blower is provided with a filter. This filter should be inspected daily and cleaned weekly. After cleaning, apply a light spray of Filter Kote Oil.

The diffusion pump blower also serves to cool the Electronics, the filter - located in the bottom of the Electronics - should be checked or cleaned weekly.

All blowers are energized when the FOREPUMP circuit breaker is turned on.

H. CEE TUBE FILAMENT. (See Figure 29)

1. Indication of an Open Filament:

No sensitivity, no emission, and no emission light indicate a burned-out filament. A good filament normally has a resistance of a fraction of an ohm.

If one filament has burned out, move the Filament Selector switch to the alternate position to actuate second filament. If this has been done previously, and both filaments are burned out, remove the source from the spectrometer tube as follows:

2. How to Change a Filament

a. Procedure:

1. Close Accumulator Valve. With the machine running in normal operating condition, a filament may be changed without completely shutting down. Close the Accumulator Valve to allow the Diffusion Pump and Forepump to continue pumping during the maintenance operation. Remove screws holding refrigerant bucket.

NOTE

MS-17A users will turn off Electronics, remove the source cable, vent the external roughing system, open the Throttle Valve, and proceed to Step (4). MS-17AB users proceed to Step (2).

2. Turn off ELECTRONICS.

CAUTION

REMOVE SOURCE CABLE: This opens the Repeller Heater Circuit, thereby preventing oxidation of the repeller during maintenance periods, when it is exposed to atmospheric pressure.

3. With the mode switch in MANUAL, and the THROTTLE VALVE open, vent the Test Manifold Port by placing the START-VENT Switch in VENT. While still holding the Vent Switch, press the TEST VALVE PUSH TO OPEN Button. On AB models, this opens the Test Valve thus venting the Spectrometer Tube and Cold Trap, up to accumulator valve.

4. Remove the refrigerant bucket and decant the liquid nitrogen. Clean, then dry the refrigerant bucket thoroughly (Use VEECO Degassing Gun. Cat. #QD 12500) and replace. Remove the three screws holding the source flange and carefully remove the source assembly from the Cee Tube. Note: An alignment pin will not permit the source to be repositioned in the Cee Tube other than in the same position as it was removed.

5. Remove the nuts holding the filament leads. The filaments are then held in place by two ceramic blocks, secured by 1/4" hex. nuts. Remove these, thus freeing the filament bodies from the clamping action of the ceramic blocks.

6. Discard the burned out Filaments.

7. The Ionization Chamber Assembly should be cleaned before replacing new Filaments. A piece of emery, suitably rolled, should be used to clean the assembly and slit (part 11) of all carbonization.

8. With the filament body lying in place in the grooves on the filament mounting block, in such a direction that the filament "hangs" over the ceramic clamp, place the front ceramic holder in place and lightly fasten with

the 1/4" hex nuts. Carefully raise the filament body so that the ceramic part is touching up against the rear ceramic clamp piece, thus correctly positioning the filament so that it exactly aligns with the slot in the race-track shaped box behind it. Tighten the 1/4" hex nuts. CAUTION! Excess torque will crack the ceramics. Use finger torque wrench supplied with the MS-17. Repeat this procedure when installing second filament.

9. New filaments are shipped with the leads straight but which are easily bent into the proper position for attachment to the terminals of the source.

Fasten the leads to the terminals with the four nuts previously removed. The source may now be replaced in the spectrometer tube. Be sure the "O" ring and flange are clean to assure a vacuum tight seal. Apply a very light coat of vacuum grease to the O-ring.

10. Tighten the source in place with the three holding screws. It is now necessary to evaculate the spectrometer tube with the roughing pump on models MS-17AB and MS-17ABC as follows:

Plug the test manifold (ports). The mode switch should be still in MANUAL and the throttle open. Put the start vent switch in start and press the TEST VALVE PUSH TO OPEN switch. This opens the roughing pump valve and the test valve allowing the roughing pump to evacuate the Cee Tube, test-manifold, and cold trap system up to the Accumulator Valve. When the manifold pressure is approx 50 microns, release the TEST VALVE PUSH TO OPEN button (closing the test valve) and place the mode switch in AUTOMATIC. The Accumulator Valve is then opened and the system allowed to pump down using the Diffusion and Forepump.

11. Replace the source cable. Place the filament selector switch in either position. Wait two minutes before proceeding.

12. Turn on ELECTRONICS. When the Pressure Meter indicates pressures of approx 1×10^{-4} torr, add liquid nitrogen to the cold trap. Push the FILAMENT ON switch. When filament is in operation, check the emission and set if necessary. Check sensitivity.

I. FILAMENT PROTECTIVE CIRCUIT

There are 4 sets of contacts in series which must be closed to supply power to the Cee Tube filament. These contacts are listed below:

1. FOREPUMP switch
2. DIFFUSION PUMP switch

3. ELECTRONICS switch

4. Discharge Gauge Relay

This relay opens the filament circuit if the pressure exceeds 3 x 10^{-4} torr.

J. ELECTRICAL PRESSURE GAUGES

1. Discharge Gauge and Circuit. (HI-VAC Pressure)

(a) Circuit (See Figure 10)

The Discharge Gauge requires: a source of 330 volts D.C. The Discharge Gauge Circuit supplies this voltage to the gauge when the Electronics circuit breaker is turned on.

The rectification circuit is a half-wave rectifier converting the 2300 Volts from the secondary of a transformer (filtered by capacitors) to 3300 Volts D.C. The three 390 K resistors limit the current to protect the circuit, should a short-circuit occur in the discharge gauge or cable. A relay provides protection for the Cee Tube filament by opening the filament supply circuit when the pressure exceeds 3 x 10-4 torr.

Oscillations developing in the HI-VAC PRESSURE meter usually indicate a dirty Discharge Gauge.

(b) Cleaning The Discharge Gauge (See Figures 32 and 33)

When it has been determined that the discharge gauge is contaminated, it should be removed from the vacuum system and cleaned. The step-by-step instructions are as follows:

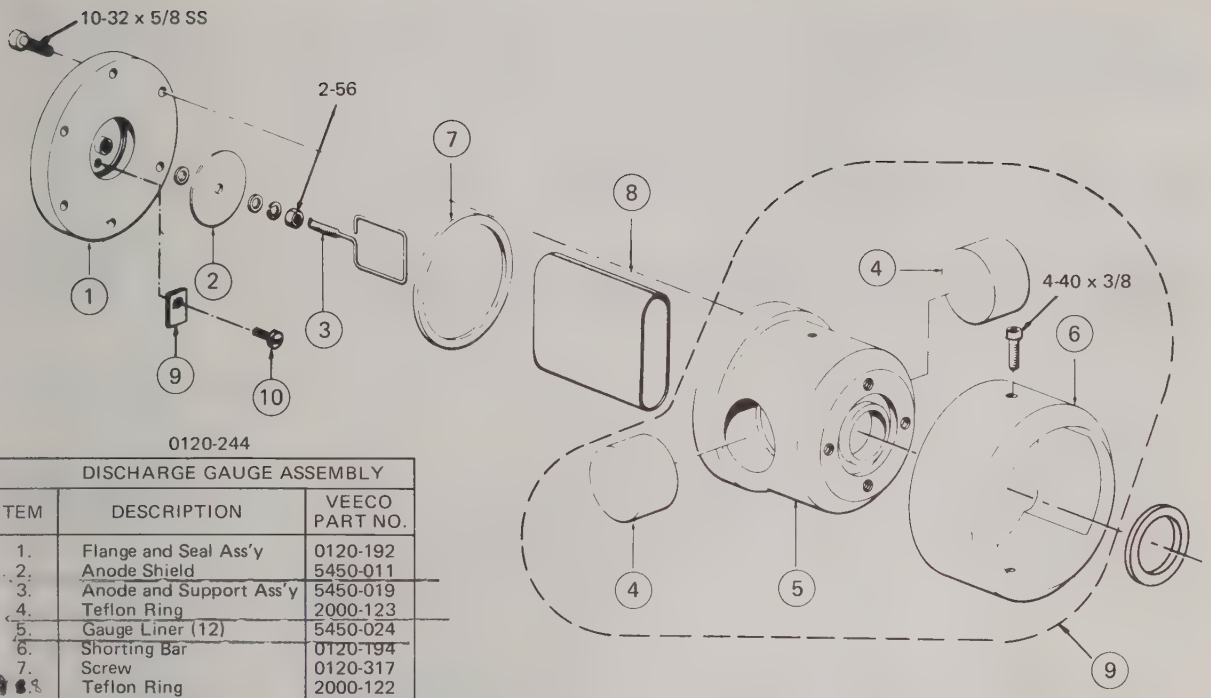
(1) Admit air into the Cee Tube and Discharge Gauge by following the procedure listed below:

(i) Close the Accumulator Valve (this allows the diffusion pump to continue operating during the maintenance period).

(ii) MS-17A users will turn off the Electronics, remove the source cable, and vent the Cee Tube by opening the Throttle Valve.

(iii) Remove the source cable. This opens the repeller heater circuit, thereby preventing oxidation of the repeller during the maintenance period.

(iv) Turn off the Electronics and place the METHODS SWITCH in MANUAL. Place the START-VENT switch to VENT and hold it there. Now push the TEST VALVE PUSH TO OPEN Switch in the Sub Panel.



0120-244

DISCHARGE GAUGE ASSEMBLY		
ITEM	DESCRIPTION	VEECO PART NO.
1.	Flange and Seal Ass'y	0120-192
2.	Anode Shield	5450-011
3.	Anode and Support Ass'y	5450-019
4.	Teflon Ring	2000-123
5.	Gauge Liner (12)	5450-024
6.	Shorting Bar	0120-194
7.	Screw	0120-317
8.	Teflon Ring	2000-122
9.	Body & Magnet Ass'y	5420-019
10.	Abrasive Paper	5450-027

Figure 32. Modified DG-3 Discharge Gauge, Exploded View

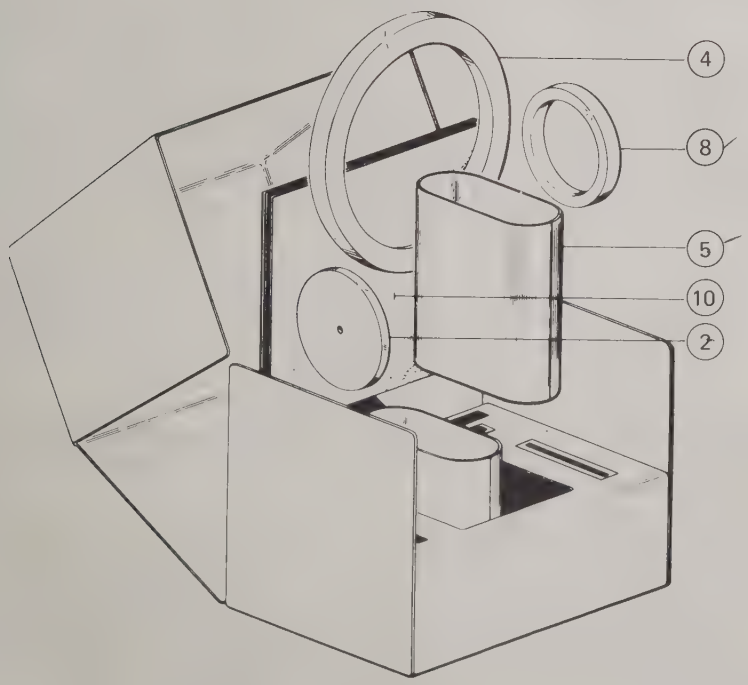


Figure 33. Discharge Gauge Replacement Liner Kit (P/N 5450-025)

On AB models, this opens the test valve. Since the port is open to air, the Cee tube, discharge gauge, and cold trap are vented up to the accumulator valve.

(v) Remove the cold trap and empty the liquid nitrogen. Wash with clean Acetone, dry thoroughly (VEECO Degassing Gun, Cat. #QD 12500 is recommended) and replace.

(2) Disconnect the discharge gauge cable. Contact is pressure type and may be removed by pulling on rubber cap. GROUND THE CABLE END MOMENTARILY to discharge capacitors C3 and C4.

(3) Remove the six allen head screws from the anode flange assembly and carefully withdraw the anode flange assembly from the gauge body.

(4) Remove the anode loop from the flange by loosening the locking nut and then unscrewing the loop from its seating. Be careful to keep account of all washers and the ceramic shield.

NOTE

Since the glass to metal seal on the anode flange is fragile, this piece should be handled with care to avoid breakage.

(5) Clean the anode loop by polishing it with abrasive paper; be careful not to distort or damage the loop during cleaning.

(6) Clean the anode flange with a lint-free rag moistened with a solvent such as Acetone. Be sure that the glass insulator around the central pin is free of dirt and scratches; otherwise electrical shorts may develop. If a discoloration is present on the flange, it may be removed by using fine emery paper, and then by cleaning with solvent.

(7) Inspect the spark gap. If there is any dirt or metal whiskers between the pin and the strap, carefully remove this extraneous material. Also remove any impurities that may be found on the top of the strap. Spark gap setting is .007 inch ± .001 inch.

(8) Inspect the teflon gasket; if it is badly deformed or compressed, replace it with the new one provided in the Replacement Liner Kit (part number 5450-025).

(9) Slide the old liner from the cavity of the body of the discharge gauge and discard. Clean the new liner provided in the Replacement Liner Kit with lint-free rag moistened with a solvent such as Acetone. Be careful not to distort the liner. Dry the liner thordughly and insert it into the body of the gauge. Avoid leaving any fingerprints on the new liner during this process.

(10) Inspect the ceramic shield from anode assembly. If dirt or discoloration is evident, replace it with the new shield from the Replacement Liner Kit. If left dirty, it will result in an anode to cathode short circuit and will render the gauge ineffective.

(11) Clean all parts of the anode loop assembly with a chlorinated solvent. Re-assemble the anode loop assembly, placing the lock nut, washers, and shield. Secure the anode loop into the central pin of the flange to finger tightness only, making sure that the plane of the loop lines up with one pair of flange holes.

(12) Replace the teflon gasket in its groove on the flange; be sure that both the groove and gasket are free of dirt and lint.

(13) Re-assemble the flange to the body so that the plane of the anode loop is parallel to the flat sides of the liner; be sure that the loop does not touch the liner. Replace the allen head screws, tightening down evenly on opposite screws.

(14) Connect the high voltage cable by pressing it down over the central pin. Evacuate the system.

(15) Activate and, if necessary, align the spectrometer tube and use the MS-17 for leak checking itself by probing the gauge and cold trap flanges with helium.

2. Pirani Gauge and Control Circuit (Manifold Pressure)

Principle: Within certain limits, the thermal conductivity of a gas is dependent on its pressure. This physical phenomenon is utilized for the purpose of pressure measurement in the Pirani Gauge. In the Veeco gauge, the current in the sensor (a very thin tungsten filament) is maintained constant regardless of the pressure in the gauge - So the temperature of the filament varies with the pressure; measurement of this change of filament resistance with temperature change gives an indication of the pressure. As the filament is thin and the electronic system associated with the sensor is fast, the Pirani gauge reacts rapidly to changes of pressure.

K. CALIBRATION OF PIRANI AMPLIFIER (BOARD "E")*

With the electronic system connected to the vacuum system and the circuit breakers "on"; calibrate the Pirani amplifier as follows: (See Figure 24)

1. R704 (on sensor head - accessible through side) to be adjusted after venting system (ATM) for full scale of meter.

2. R644 (on Board "E") to be adjusted when unit is in vacuum 10^{-4} torr or less), so that meter reads 1 millitorr.

3. The following are factory adjustments and should not be readjusted: R624, R610, R615.

*For units having serial number prefix -01 (or higher) only. See Addendum for units having serial number prefix -00.

Section V

RECOMMENDED SPARE PARTS

A. MS-17A, AB, C SPARE PART NUMBER MATRIX*

	MS-17A	MS-17AB	MS-17C
General Maintenance Kits, 60 Hz, 110V	0126-188-01	0126-184-01	0126-229-00
General Maintenance Kits, 50 Hz, 220V	0126-188-02	0126-184-02	0126-229-00
General Maintenance Kits, 50 Hz, 110V	0126-188-03	0126-184-03	0126-229-00
O-Ring Kits	0126-170-00	0126-171-00	0126-172-00
Mass Spectrometer Tube			
Collector Assy	0126-175-00	0126-175-00	N/A
Collector Rebuild Kit	0126-228-00	0126-228-00	N/A
Source Assy	0103-115-00	0103-115-00	N/A
Source Rebuild Kit	0126-186-00	0126-186-00	N/A
Source Filament (5)	0103-141-01	0103-141-01	N/A
Diffusion Pump (complete), 110V	0126-024-01	0126-024-01	
Diffusion Pump (complete), 220V	0126-024-02	0126-024-02	N/A
Diffusion Pump Heater, 110V	1180-045-00	1180-045-00	N/A
Diffusion Pump Heater, 220V	1180-223-00	1180-223-00	
Jet Stack Kit	4530-010-00	4530-010-00	N/A
Octoil (qty req'd & PN)	1990-022-00(2)120cc	1990-022-00(2)120cc	N/A
Throttle Valve, "A" only (stem and bellows	0126-217-00	MANUAL OVERIDE OF TEST VALVE, SEE TEST/THROTTLE VALVE	N/A
Throttle Valve (O-Ring Kit)	0126-813-00		N/A
Test Valve	SEE TEST/THROTTLE VALVE		N/A
Test Valve O-Ring Kit	SEE TEST/THROTTLE VALVE		N/A
Test/Throttle Valve "AB" only (stem and bellows)	0126-810-00	0126-810-00	N/A
Test/Throttle Valve (O-Ring Kit)	0126-811-00	0126-811-00	N/A
Accumulator Valve (Complete)	0126-008-00	0126-008-00	N/A
Accumulator Valve (O-Ring Kit)	0126-812-00	0126-812-00	N/A
Roughing Valve (stem and bellows)	0126-810-00	0126-810-00	2430-001-00
Roughing Valve (O-Ring Kit)	0126-811-00	0126-811-00	2430-003-00
Vent Valve (complete)	N/A	0119-067-00	N/A
Vac Guard Valve	N/A	N/A	N/A
Vac Guard Rebuild Kit	N/A	N/A	N/A
Hi Vac Gauge (complete)	0120-244-00	0120-244-00	N/A
Hi Vac Rebuild Kit	5450-025-00	5450-025-00	N/A
Hi Vac Gauge Liners (12)	5450-024-00	5450-024-00	N/A
Hi Vac Flange & Anode	0120-192-00	0120-192-00	N/A
Roughing Gauge, Black case	5600-020-00	5600-020-00	1540-015-00
Roughing Gauge, Alum. case	5600-100-00	5600-100-00	1540-015-00
Solenoid Coil Kit	N/A	0126-233-00	1180-118-00
Fan Assy's			
Source	1851-204-80	1851-204-80	N/A
Diffusion Pump, 110V	1180-129-00	1180-129-00	N/A
Diffusion Pump, 220V	1180-130-00	1180-130-00	N/A
Cabinet	1180-222-00	1180-222-00	N/A
Pilot Lamp Kits	0126-230-00	0126-231-00	Incl'd in Maint. Kit
Circuit Boards: "A" Power Supply	1077-401-80	1077-401-80	N/A
"B" Amplifier	1077-402-80	1077-402-80	N/A
"C", DC Supply	1077-403-80	1077-403-80	N/A
"E", Logic	1077-404-80	1077-404-80	N/A
Circuit Board Kit (1 ea. A,B,C,E)	N/A	0126-173-00	N/A

* For units having serial number prefix -01 (or higher) only. See Addendum for units having serial number prefix -00.

B. SPARE PARTS LISTING

1. General Maintenance Kits

		Part Number
MS-17A	110V 60 Hz	0126-188-01
	220V 50 Hz	0126-188-02
	110V 50 Hz	0126-188-03
MS-17AB	110V 60 Hz	0126-184-01
	220V 50 Hz	0126-184-02
	110V 50 Hz	0126-184-03
MS-17C	50 & 60 Hz	0126-229-00

MS-17A,AB includes: (See "C" Parts List for items contained in "C" Maintenance Kit)

- (4) 60cc. bottle Diffusion Pump oil-octoil, 120 cc. per change
- (1) Discharge gauge liner kit
- (1) Silicone grease, 8 oz.
- (1) O-ring kit
- (1) Air filter-rear door
- (1) Fir filter-electronics
- (2) Vee belts-forepump
- (2) Vee belts-roughing pump (AB kits only)
- (3) Qts. mechanical pump oil
- (1) Box (5) filaments
- (1) Diffusion pump heater
- (1) Set pilot lamps

2. "O" Ring Kits

MS-17A	0126-170-00
MS-17AB	0126-171-00
MS-17C	0126-172-00

3. Mass Spectrometer Tube (Cee Tube)

MS-17 collector	0126-175-00
Collector rebuild kit	0126-228-00
Includes: (1) Coated resistor, (1) Preamplifier tube	
MS-17 source assembly	0103-115-00
Filaments for above (box of 5)	0103-141-01
Source rebuild kit	0126-186-00
Includes: Necessary source elements and ceramics to rebuild source	

			Part Number
4. Diffusion Pump and Components			
Diffusion pump heater	110V		1180-045-00
	220V		1180-223-00
Jet stack kit	Includes:	complete jet stack	4530-010-00
		foreline baffle	
Octoil - 60cc. (2 bottles reg.)			1990-022-00
5. Throttle Valve (MS-17A only)			
Stem and bellows			0126-217-00
Rebuilt kit Includes:	(1)	Seat	0126-813-00
	(1)	Throttle gate	
	(1)	Set O-rings	
6. Test Valve			
See Test/throttle valve			
7. Test/Throttle Valve			
Stem and bellows			0126-810-00
O-ring kit-contains	(5)	sets of O-rings	0126-811-00
8. Accumulator Valve			
Complete assembly			0126-008-00
O-ring kit-contains	(5)	sets of O-rings	0126-812-00
9. Roughing Valve			
Stem and bellows			0126-810-00
O-ring kit-contains	(5)	sets of O-rings	0126-811-00
10. Vent Valve			
Complete assembly			0119-067-00
11. HI Vac Gauge			
Complete gauge			0120-244-00
Rebuild kit			5450-025-00
Gauge liners (12)			5450-024-00
Flange and anode			0120-192-00
12. Roughing Gauge (Pirani)			
Black case			5600-020-00
Aluminum case			5600-100-00

		Part Number
13. Solenoid Coil Kit (MS-17AB only)		
Complete kit includes: (1) Vent valve coil (2) Vacuum valve coils		0126-233-00
14. Fan Assemblies		
Source		1851-204-80 $105.00
Diffusion pump	110V	1180-129-00
	220V	1180-130-00
Cabinet		1180-222-00
15. Pilot Lamp Kits		
MS-17A	Contains (2) sets replacement lamps	0126-230-00
MS-17AB	Contains (2) sets replacement lamps	0126-231-00
Retrofit kit -	Contains sockets necessary to use replaceable type bulbs supplied in lamp kits. (9 sockets)	0126-814-00
NOTE:	If unit has front panel replaceable lamps, retrofit is not necessary.	
16. Circuit Boards		
"A" Power supply		1077-401-80
"B" Amplifier		1077-402-80
"C" DG Supply		1077-403-80
*"E" Logic		1077-405-80
PC Board Kit - (1) each A,B,C,E		0126-173-00

C MISCELLANEOUS VACUUM PARTS LISTING

1. Mechanical Pump Parts - 60 Hz Only	
Belt, Forepump	1920-006-00
Belt, Roughing pump	1920-009-00
Motor, Forepump (1400) 1/3 hp	1180-055-00
Motor, Roughing (1402) 1/2 hp	1180-058-00
Motor, Roughing (1376) 1 hp	1180-065-00
Pump only (1400) .7 cfm	1670-017-00
Pump only (1402) 5.6 cfm	1660-034-00
Pump only (1376) 10.6 cfm	1670-001-00
Oil, DuoSeal for above pumps, 1 qt.	1990-001-00
2. Mechanical Pump Parts - 50 Hz Only	
Belt, Forepump	1920-008-00
Belt, Roughing pump	1680-033-00
Motor, Forepump (1400) 1/3 110V	1180-056-00
220V	1180-054-00

*See Addendum

	Part Number
Motor, Roughing pump (1402) 1/2 hp 115/220V	1180-057-00
Motor, Roughing pump (1376) 1 hp 115/220V	1180-063-00
Pump only (1400)	1670-017-00
Pump only (1402)	1670-034-00
Pump only (1376)	1670-001-00
Oil, Duoseal, 1 qt.	1990-001-00

3. Valves

Solenoid vacuum control valve	1999-014-80
Solenoid vent valve	0119-067-00
Stem and bellows assy, complete	0126-810-00
Accumulator valve	0126-008-00
Check valve	1890-075-00

4. Vacuum Hose (1 Ft. Long)

Forepump hose (1400)	1750-004-00
Roughing pump hose (5 cfm-1420)	1750-011-00
Roughing pump hose (10 cfm-1376)	1750-012-00

D. MISCELLANEOUS ELECTRICAL PARTS

1. Meters

Discharge gauge meter (M1)	1534-025-80
Leak meter (M501)	1534-022-80
*Pirani meter (M2)	1534-031-80

2. Relays

Filament relay KF	1768-017-80
Pirani relay KP	1768-018-80

3. Switches

S 1 Start Vent	1770-039-00
S 2 Fil Selector	1771-024-80
S 3 Meter Range	1772-029-80
S 4 Test-Push to open	1770-007-00
S 5 Fil. On-Off	1771-050-80
S 6 Fil. Volt. Sel.	1772-044-80
S 7 Man-Auto	1771-024-80
S 8 Peak Scan	1770-032-00

*See Addendum

4. Circuit Breakers			Part Number
Forepump CB 1	115V-20A		1777-408-80
	230V-10A		1777-411-80
Diffusion pump CB 2		115V-4A	1777-406-80
		230V-1.5A	1777-420-80
Electronics CB 3	115V-4A		1777-406-80
	230V-2.5A		1777-420-80
Roughing pump CB 4		115V-15A	1777-409-80
		230V-5A	1777-410-80

5. Potentiometers			
Repeller R 9			1644-199-80
Ion focus R 12/13			1644-044-80
Ion center R15/16			1644-045-80
Emission R17			1644-212-80
Peak tune R 19			1643-066-80
*Crossover set R20/S9			1642-161-80
Zero adj-fine R515			1642-579-80
Zero adj-coarse R514			1643-066-80
Volume	R503	audio	1642-353-80
Preset	R502	visual	1642-581-80
Calibrate	R506	only	1644-251-80

6. Transformers		
T 1	60 Hz	1822-061-80
	50 Hz	1822-062-80
T 2	60 Hz	1822-063-80
	50 Hz	1822-964-80
T 3	50/60 Hz	1822-041-80
T 5	50 Hz only	1822-066-80

E. "C" MODULE PARTS LISTING

1. General Parts

Roughing pump complete, 1405B	1660-013-00
Belt, roughing pump, 1405	1680-032-00
Motor, roughing pump, 1405, 1/2 hp, 110/220V, 60 Hz	1180-058-00
Motor, roughing pump, 1405, 1/2 hp, 110-220V, 50 Hz	1180-057-00
Pump only, 1405	1660-035-00
Solenoid valve, complete (SV62DC)	2430-001-00
Pin & disc assy for solenoid valve	1430-003-00
Coil for solenoid valve	1180-118-00
Bourdon gauge	1540-015-00
Bell jar, 8 3/4" od x 15" h	1240-005-00

*See Addendum

2. MS-17C - General Maintenance Kit

	Part Number
Complete Kit	0126-229-00

Includes:

(4)	Pilot Light
(12)	Plastic Ferrule, 3/8
(20)	Plastic Ferrule, 1/4
(3)	Ft. Poly Flo Tubing, 3/8
(9)	Ft. Poly Flo Tubing 1/4
(1)	Hi Vac Grease
(1)	Vee Belt
(2)	Duo-seal Oil
(1)	MS-17C "O" ring Kit

small charge of liquid nitrogen into the trap, then after three minutes, add sufficient liquid nitrogen to fill the trap. The system pressure should drop to 5 x 10^{-5} torr or lower in a few minutes.

CAUTION

Never obstruct the filler opening of the cold trap fill pipe as pressure builds up due to nitrogen evaporation.

6. Push FILAMENT ON switch. This should light the EMISSION lamp on the front panel and on the leak indicator. (If the system pressure rises higher than approximately 3 x 10^{-4}, the filament is automatically turned off).

2. Sensitivity Check

Before using the MS-17A for leak testing, a sensitivity check should be made. At the end of the day, this check should be repeated.

a. Procedure

1. Close the throttle valve and remove the plugs from the port and sensitivity calibrator. Insert the sensitivity calibrator into the test port. Check to see that the valve on the sensitivity calibrator is open so it can be pumped down at the same time the manifold is pumped (see Figure 19).

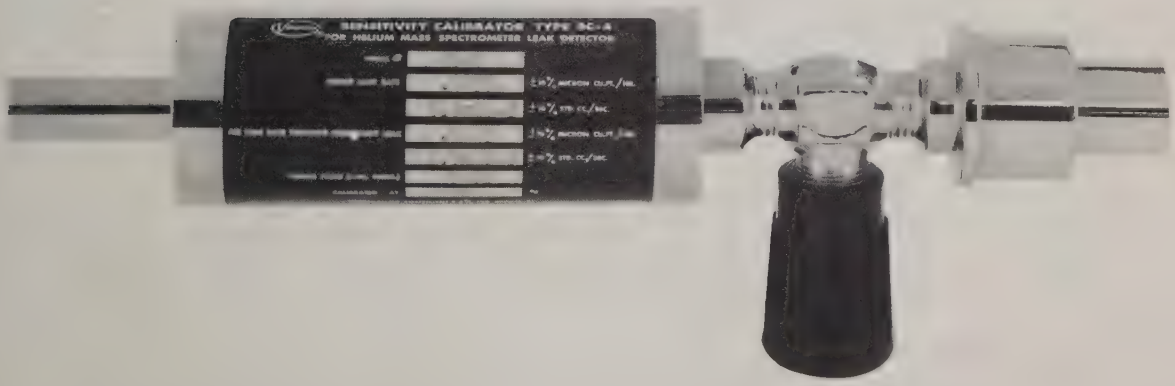


Figure 19. Sensitivity Calibrator, SC-4

2. With FILAMENT OFF, set the leak indicator meter to zero by means of its ZERO ADJUST knob. If necessary use the COARSE ZERO ADJUST control located on the rear of remote box. Push FILAMENT ON switch. It is impossible to perform a test unless the filament is on.

3. Rough down the port manifold by means of an auxiliary vacuum system, and slowly open the THROTTLE VALVE while maintaining the HI-VAC PRESSURE meter reading at 10^{-4} torr or lower. If the pressure is allowed to rise above 3×10^{-4} torr the filament will automatically turn off. If this occurs close the throttle valve slightly and press the FILAMENT ON switch.

4. Valve off the external system. With the throttle valve open full and the filament on, a known (marked on SC-4 sensitivity calibrator) leakage of helium is entering the machine.

5. Note the deflection of the leak Indicator. If it does not correspond to the reading on the SC-4 (for air), adjust the CALIBRATE control (on the rear of the leak indicator) for direct readout. If the setting cannot be reached, see ELECTRICAL ALIGNMENT OF THE CEE TUBE. The MS-17 is now calibrated for Air Leak Rate direct reading, sensitivity is 6×10^{-11} atm cc./sec. which is 2% of the 1st scale.

6. Close the THROTTLE VALVE.

7. Vent the port manifold, remove the sensitivity calibrator, plug end with plastic stopper provided for this purpose.

CAUTION

DO NOT leave the calibrator valve in the closed position. Prolonged closure or excessive closing force may result in permanent damage to the metal-to-metal seat surfaces.

By performing this sensitivity check daily with a known input of Helium, a constant check on the sensitivity of the machine is obtained. More frequent sensitivity checks should be made for larger production loads and more critical tests.

3. Leak Testing

Once the sensitivity check has been accomplished, the MS-17A is ready to perform leak testing. Connect object to be tested to the port desired, "rough" object out, and "throttle" into the leak detec-

E. CLEANING PROCEDURES (See Figure 27)

1. General

a. In the event a vacuum system becomes contaminated by high vapor pressure materials, not easily removed by pumping and mild baking, it is necessary to disassemble and clean all component parts affected.

b. Many organizations have established cleaning procedures for vacuum apparatus, such as electron tube parts, test chambers, etc. These methods will normally be appropriate for cleaning the mass spectrometer system.

c. Although metal and glass sections may be placed in a hot vapor degreaser as a first-step cleaning procedure, this is not recommended unless great care is taken to insure proper hot vapor degreasing techniques, and the use of solvents that will not further contaminate the part being cleaned.

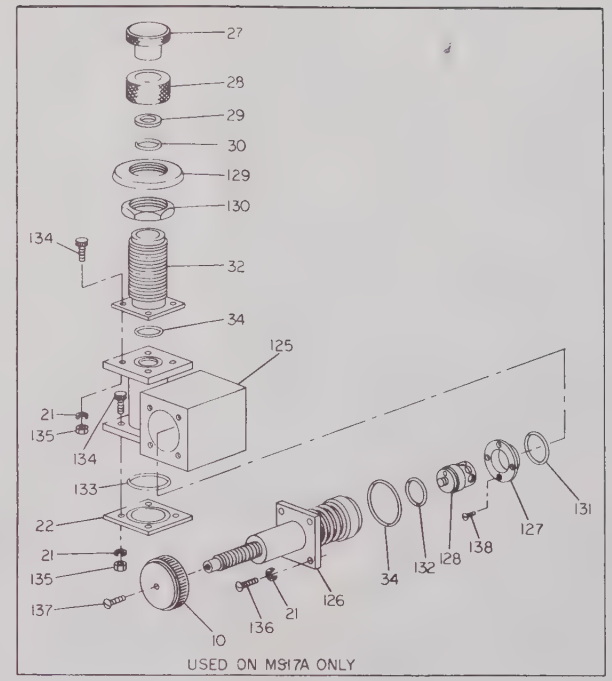
d. Internal surfaces that can be reached with clean cloth swabs should be physically swabbed out, using a minimum of degreasing solvent on the swab. Internal portions of the system that cannot be reached must be flushed with enough solvent to allow all surfaces to be wet, and as much physical action employed (shaking and sloshing) as practicable.

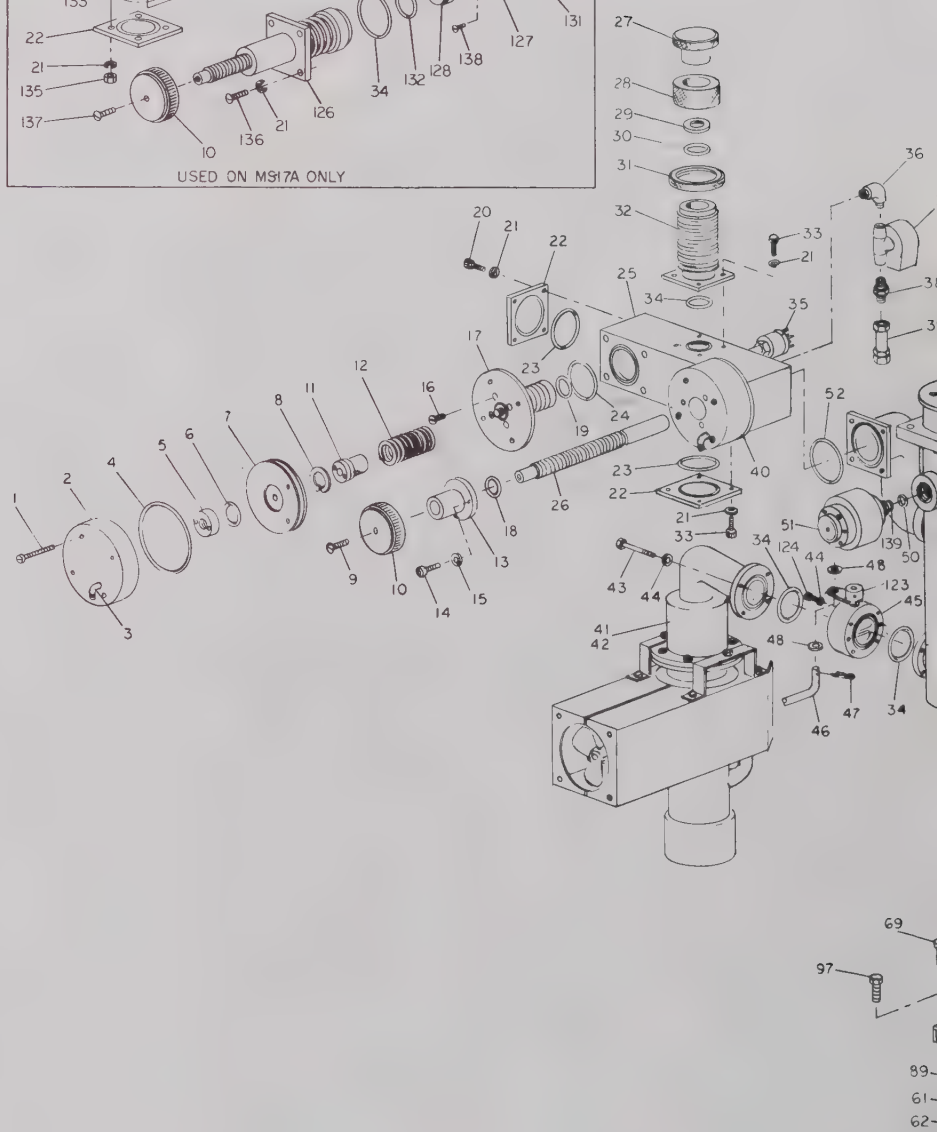
e. Synthetic rubber "O" rings (usually Neoprene) are susceptible to absorbing large quantities of the solvents used in cleaning, the subsequent evaporation of these solvents when a system is evacuated must be avoided, therefore "O" rings and gaskets should be removed from the flange grooves and treated as a separate cleaning problem. "O" rings and gaskets are either replaced at the time of reassembly (and this is recommended), or carefully wiped clean with a lint-free material, and inspected for surface damage of any kind before they are used again. If new rings are used, they should be wiped, inspected and lubricated in the same manner as used rings.

NOTE

Never remove "O" rings with a metal tool, as this will invariably scratch the "O" ring groove, causing a potential - if not actual - leak. Use plastic (e.g., corner of a plastic badge, etc.) or wood (e.g., toothpick, etc), and remove "O" ring by inserting tool between outside of "O" ring and groove, and sliding around "O" ring. This will cause "O" ring to "pop up" ("O") ring may have to be held on opposite side to prevent turning in groove), and generally gives better results than trying to "pry" the "O" ring from the groove.

ITEM	IDENTIFICATION	PART NO.
1	SCREW, PAN HD, NO. 6-32 X 1-5/8	COML
2	CYLINDER ROUGHING	0126-049
3	ELBOW	1620-727
4	"O' RING	0011-340
5	STEM NUT	0126-042
6	' O" RING	0011-015
7	PISTON	0126-041
8**	TRUARC RING INT.	1330-722
9	SCREW, CTSK, OVAL-HD, NO. 10-32X1/2	COML
10	KNOB	1320-057
11**	STEM GUIDE	0126-077
12**	SPRING	1330-721
13	COLLAR	0126-043
14	SCREW, SOC.-HD, NO. 6-32X1/2	COML
15	LOCKWASHER, SPLIT, NO. 6	COML
16	SCREW, FLT-HD, NO. 1/4-20X5/8	COML
17**	STEM, CAP AND BELLOWS ASSEMBLY	0126-047
18	"O" RING	0011-113
19**	"O'RING	0011-217
20	SCREW, SOC-HD, NO. 10-32X5/8	COML
21	LOCKWASHER, SPLIT NO. 10	COML
22	BLANK FLANGE	0126-078
23	'O' RING	0011-222
24*	' O" RING	0011-225
25	VALVE BLOCK	0126-026
26	THROTTLE STEM	0126-044
27	BLANK PLUG	0103-317
28	Q.C. NUT	0103-313
29	Q.C. WASHER	3140-003
30	' O" RING	0011-216
31	MOUNTING RING	0126-235
32	TEST PORT ASSEMBLY	0126-075
33	SCREW, SOC-HD, NO. 10-32X3/4	COML
34*	"O" RING	0011-223
35	PIRANI TUBE ASSEMBLY	5600-020 or 100***
36	ELBOW	1620-740
37	VENT VALVE ASSEMBLY	0119-067
38	NIPPLE	1620-749
39	MICRON FILTER	1890-015
40	CYLINDER TEST	0126-040
41	DIFF. PUMP AND FAN ASSEMBLY - 115. OR	0126-024-01
42	DIFF. PUMP AND FAN ASSEMBLY - 230 V.	OR 0126-024-02
43	SCREW, SOC-HD, 1/4-20X1-5/8	COML
44	LOCKWASHER, SPLIT, 1/4	COML
45	ACCUMULATOR VALVE	0126-008
46	ACTUATOR ROD	0126-120
47	COTTER PIN	1330-745
48	WASHER, FLAT NO. 10	COML
49	COLD TRAP ASSEMBLY	0126-050
50	"O" RING	0011-016
51	MODIFIED DG 3 ASSEMBLY	0120-244
52	"O" RING	0011-220
53	'O" RING	0011-224
54	CEE TUBE ASSEMBLY- MS-17 SERIES	0126-065
55	ROUGH MANIFOLD ASSEMBLY	0126-073
56	CLAMP (LARGE)	1330-035
57	HOSE CONN., ROUGHING	1750-011
58	HOSE CONN., ROUGHING	1750-012
59	CEE TUBE SPACER	0126-219
60	BOLT, HEX-HD, NO. 1/2-20X7/8	COML
61	WASHER, FLAT, 1/4	COML
62	NUT, HEX, 1/4-20	COML
63	FORELINE MANIFOLD ASSEMBLY	0126-139
64	HOSE CONN., FORELINE	1750-004
65	CLAMP	1330-034
66	REF. BUCKET ASSEMBLY	0126-060
67	FORE PUMP ASSEMBLY 60C	0126-097-01
68	FORE PUMP ASSEMBLY 50C	0126-097-02
69	BOLT, HEX HD., 5/16-18X3/4	COML
70	LOCKWASHER, SPLIT 5/16	COML
71	WASHER, FLAT, 5/16	COML
72	DIFF. PUMP SUPPORT	0126-123
73	SUPPORT CLAMP	0126-124
74	BOLT, HEX-HD, 1/4-20X1-1/2	COML
75	TERMINAL STRIP	1840-052
76	SCREW, PAN-HD, NO. 10-32X3/4	COML
77	SHIELD ASSEMBLY	0126-183
78	SCREW, PAN HD., NO. 8-32X1-1/2	COML
79	WASHER, FLAT, NO. 8	COML
80	LOCK WASHER, SPLIT, NO. 8	COML
81	10 CFM PUMP, 115V. 60C	0126-064-01
82	5 CFM PUMP, 115 V 60C	0126-064-02
83	10 CFM PUMP, 230V, 50C	0126-064-03
84	5 CFM PUMP, 230V, 50C	0126-064-04
85	10 CFM PUMP, 115V, 50C	0126-064-05
86	5 CFM PUMP, 115V, 50C	0126-064-06
87	CABINET FRAME	0126-010
88	BALLAST ADAPTOR	0126-099
89	VIBRATION MOUNT	1330-479
90	PLATE	0126-443
91	MALE ELL 90° 1/4 MPT	1620-740
92	CHECK VALVE	1890-075
93	CONNECTOR	1620-702
94	1376 PUMP BASE MOD	0126-021
95	VEE BELT	1680-033
96	VEE BELT	1920-009
97	BOLT, HEX-HD., 1/4-20X3/4	COML
98	MOTOR, 115/230V, 50 CYC	1180-057
99	MOTOR, 115/230V, 60 CYC	1180-058
100	MOTOR, 115/230V, 50CYC	1180-063
101	MOTOR, 115/230V, 60 CYC	1180-090
102	PULLEY	1920-024
103	PULLEY	1920-023
104	1402 MECH. PUMP	1660-034
105	MECH. PUMP 10 CFM (1376)	1670-001
106	VEE BELT	1920-006
107	VEE BELT	1920-008
108	1/3 HP MOTOR, 60 HZ	1180-055
109	1/3 HP MOTOR, 50 HZ, 115 V	1180-056
110	1/3 HP MOTOR, 50 HZ, 230V	1180-054
111	PULLEY	1330-043
112	PULLEY	1330-041
113	SCREW, FLT-HD, 1/4-20X7/8	COML
114	ELASTIC LOCKNUT, 1/4-20	COML
115	1400 PUMP BASE	0126-096
116	BOLT, HEX HD, 5/16-18X5/8	COML
117	1400 PUMP	1670-017
118	1400 PUMP MTG. BRACKET	0126-095
119	BOLT, HEX-HD, 5/16-18X7/8	COML
120	ELASTIC LOCKNUT, 5/16-18	COML
121	TERMINAL BLOCK ASSEMBLY	0126-443
122	BRACKET, BARRIER STRIP	0126-439
123	ACCUMULATOR VALVE ACTUATOR	0126-127
124	BOLT, HEX-HD., 1/4-20X1-5/8	COML
125	THROTTLE VALVE BRAZ.	0126-211
126	STEM, CAP AND BELLOWS ASSY	0126-217
127****	VALVE SEAT	0103-269
128****	THROTTLE GATE	0103-275
129	MOUNTING RING	0103-315
130	MOUNTING NUT	0103-316
131****	"O" RING	0011-116
132****	"O" RING	0011-212
133	"O" RING	0011-219
134	SCREW, SOC.-HD., NO. 10-32X7/8	COML
135	NUT, HEX, NO. 10-32	COML
136	SCREW, RD.-HD., NO. 10-32X5/8	COML
137	SCREW, FLT.-HD., OVAL, NO. 10-32X1/2	COML
138	SCREW, FLT.-HD., NO. 3-56X11/32	COML
139	NIPPLE AND FLANGE ASSY	0126-247





* Sold in sets of 5 (Part No. 0126-811)
** Sold as a complete subassembly - Replacement Stem and Bellows (Part No. 0126-810)
*** See Section 5
**** Sold as part of rebuilding kit (Part No. 0126-813)

Figure 27. MS-17AB Exploded View

small charge of liquid nitrogen into the trap, then after three minutes, add sufficient liquid nitrogen to fill the trap. The system pressure should drop to 5 x 10^{-5} torr or lower in a few minutes.

CAUTION

Never obstruct the filler opening of the cold trap fill pipe as pressure builds up due to nitrogen evaporation.

6. Push FILAMENT ON switch. This should light the EMISSION lamp on the front panel and on the leak indicator. (If the system pressure rises higher than approximately 3 x 10^{-4}, the filament is automatically turned off).

2. Sensitivity Check

Before using the MS-17A for leak testing, a sensitivity check should be made. At the end of the day, this check should be repeated.

a. Procedure

1. Close the throttle valve and remove the plugs from the port and sensitivity calibrator. Insert the sensitivity calibrator into the test port. Check to see that the valve on the sensitivity calibrator is open so it can be pumped down at the same time the manifold is pumped (see Figure 19).

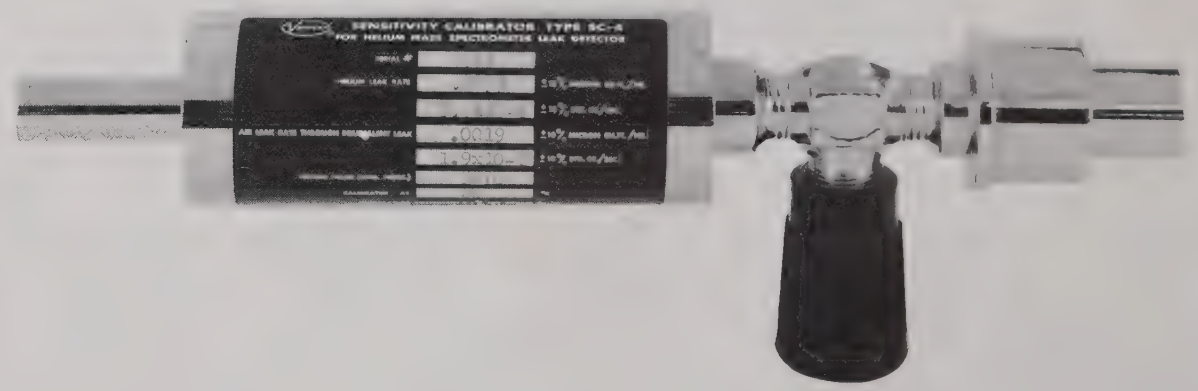


Figure 19. Sensitivity Calibrator, SC-4

Appendix A

GLOSSARY OF TERMS USED IN LEAK DETECTION

1. LEAK

In vacuum technology, a hole, or porosity, in the wall of an enclosure capable of passing gas from one side of the wall to the other under action of a pressure or concentration differential existing across the wall.

2. LEAK RATE

In leak detection practice leak rate is defined as the rate of flow (in pressure-volume units per unit time) through a leak with gas at a specified high pressure (usually atmospheric pressure) on the inlet side and gas at a pressure on the exit side which is low enough to have negligible effect on the rate of flow.

3. LEAK DETECTOR

A device for detecting and locating leaks, and indicating the magnitude thereof.

4. TRACER GAS

A gas which, passing through a leak, can then be detected by a specific leak detector and thus disclose the presence of a leak. Also called search gas.

5. PROBE GAS

A tracer gas which issues from a more-or-less fine orifice so as to impinge on a restricted test area.

6. PRESSURE TESTING

A leak detecting procedure in which tracer gas is introduced under pressure into the enclosure under examination, and detected as it is emitted from a leak.

7. SOAP BUBBLE TEST

A type of pressure testing in which the tracer gas is detected by bubbles formed in a layer of soap solution applied to the surface of the test object.

8. VACUUM TESTING

A leak detecting procedure in which the enclosure under examination is evacuated, the tracer gas applied to the outside surface of the enclosure, and the gas detected after entering the enclosure.

9. MASS SPECTROMETER LEAK DETECTOR

A mass spectrometer adjusted to respond only to tracer gas. Helium is commonly used as the tracer gas, and thus the instrument is normally referred to as a helium leak detector.

10. SPECTROMETER TUBE

The sensing element of a mass spectrometer leak detector.

11. ION SOURCE

That part of a spectrometer tube in which tracer gas is ionized preliminary to being detected.

12. NOISE LEVEL

In the case of a leak detector, the spurious output, expressed in suitable terms, exhibited by the detector in the absence of an output due to tracer gas.

13. BACKGROUND

In the case of a leak detector, the spurious output, expressed in suitable terms, due to the response to other gases than the actual gas being used for probing. The background may be inherent in the detector, or accidental.

14. MINIMUM DETECTABLE PRESSURE CHANGE

The pressure producing an indication of three times the noise level.

15. MINIMUM DETECTABLE LEAK

a. The size of the smallest leak, expressed in terms of mass flow per unit time, that can be unambiguously detected by a given leak detector in the presence of noise and background.

b. The product of the minimum detectable pressure change and the pumping speed at the detector.

16. PROBE TEST

A leak test in which the tracer gas is applied by means of a probe (see below) so that the area covered by the tracer gas is localized. This enables the individual leaks to be located.

17. PROBE

A tube having a fine opening at one end, used for directing a stream of tracer gas.

18. SAMPLING PROBE

A device used in pressure testing and so designed as to collect tracer gas from a restricted area of the test object and feed it to the leak detector. Also called pressure probe or sniffer.

19. HOOD TEST

An overall test in which an object under vacuum test is enclosed by a "hood" which is filled with tracer gas so as to subject all parts of the test object to examination at one time.

20. ISOLATION TEST

A method of determining whether a leak is present in a system, or of obtaining an estimate of its magnitude, by observing the rate of rise of pressure in the evacuated system when the system is isolated from the pump. Also called rate of rise test.

21. MASKING

The covering of a section of a test object so as to prevent tracer gas from entering leaks that may exist in the covered section.

22. FLOODED SYSTEM

A system which, while being leak tested under vacuum, becomes so filled with tracer gas as to make impracticable further leak detection by means of a probe.

23. HELIUM DRIFT

In the case of leak detection with a helium probe, the drift of helium to a leak or permeable gasket located at a point sufficiently remote from the end of the probe to mislead the operator into suspecting the area near the probe.

24. STANDARD LEAK

a. A device which permits leakage through it, at a specified rate, of a specified gas, with atmospheric pressure at one end of the device and a pressure on the other side sufficiently low to have negligible effect on the leak rate.

b. A capillary or porous wall leak, usually in a glass or metal tube, whose dimensions have been adjusted to give a conductance within specified limits for a specified gas at a standard reference temperature with specified inlet and exit pressures. Standard leaks for attaching to vacuum test manifolds with air at atmospheric pressure exposed to the inlet are usually protected by filters to avoid clogging by dust particles. Standard leaks for calibrating mass spectrometers are usually fused to a glass reservoir containing the specified gas at a known high pressure.

c. A device providing a known throughput into a vacuum system. Also referred to as a calibrated leak.

Appendix B

HIGH VACUUM UNITS AND CONVERSIONS

Pressure Units

Atmosphere pressure (sea level. 0°C) = one atmosphere
1 atmosphere = 760 millimeters of mercury
1 atmosphere = 29.92 in. Hg = 14.7 lbs. per square inch
1 mm Hg = 0.0013 atmosphere (roughly 1/1,000th of an atmosphere)
1 micron (u) Hg = 0.001 mm Hg
1 micron (u) Hg = 0.0000013 atmosphere (roughly one millionth of an atmosphere)

Pump Speed Units

1 cubic foot per minute (cfm) = 0.472 liter/second
1 liter per second (/sec) = 2.12 cfm

Note

1 cubic foot = 28.3 liters

Leakage Units

1 micron cubic foot per hour = 1 cubic foot per hour of gas at one micron Hg pressure
1 micron-liter per second = 1 liter per second of gas at one micron Hg pressure
1 standard cc per second = 1 cubic cm of gas at atmospheric pressure (often shortened to cc/sec)
1 std cc/sec = 96,600 micron cubic feet per hour (approx. 100,000)
1 std cc/sec = 760 microns liters per second
1 micron liter per second = 127 micron cubic feet per hour
1 micron liter per second = 0.0013 std cc per second
1 micron cubic foot per hour = 0.0079 micron liter per second
1 micron cubic foot per hour = 0.0000104 std cc per second (roughly one hundredth thousandth (10^{-5}) of a std cc per second

Vapor Pressure of Some Materials Used in Vacuum Practice

V.P. at 20°C.

Acetone	184.8 mm Hg.
Ethyl Alcohol	43.9 mm Hg.
Methyl Alcohol	96.0 mm Hg.
Ethyl Ether	442.2 mm Hg.
Mercury	0.0012 mm Hg.
Octoil (approx)	2×10^{-7} mm Hg.
Water	17.53 mm Hg.

Vacuum Greases* . . . . . 10^{-5} to 10^{-6} mm Hg.
Trichlorethylene . . . . . 80 mm Hg.

$\frac{5}{159}$ = .03 If the standard happened to be 5 micron cu. ft/hr. then micron cu. ft./hr. = in leakage of the system.

To find unknown leak rate: $A = \frac{B \times C}{C}$

where A = unknown leak rate
B = known leak rate
C = meter indication from unknown leak rate
D = meter indication from known leak rate

where leak rates are in micro cu. ft./hr. of helium, divide by 2.7 to obtain leak rate of air.

RULES FOR HANDLING EXPONENTIALS OF 10

EXAMPLES OF THE POWER OF TEN

10^4 =	10 x 10 x 10 x 10	= 10,000
10^3 =	10 x 10 x 10	= 1,000
10^2 =	10 x 10	= 100
10^1 =	10	= 10
10^0 =	1	= 1
10^{-1} =	$\frac{1}{10}$	= 0.1
10^{-2} =	$\frac{1}{10 \times 10}$	= 0.01
10^{-3} =	$\frac{1}{10 \times 10 \times 10}$	= 0.001
10^{-4} =	$\frac{1}{10 \times 10 \times 10 \times 10}$	= 0.0001

NOTE: 10^4 same as 1×10^4

*Vacuum greases often contain large quantities of absorbed gases and water. Consequently, maintaining low pressure in the presence of grease is difficult.

1. To transfer from a number greater than 1 to a power of 10, move the decimal point to the left as many places as desired, then write the resulting number x 10 raised to the power equal to the number of places you moved the decimal point. For example:

   a) 7,365.0
   Move the decimal point 3 places to the left to get 7.3650. Then write x 10 to the third (3) power.
   Ans. 7.3650×10^{3}.

   b) 7,365.0
   Move the decimal place only 2 places to get 73.650. Then raise 10 to the second (2) power.
   Ans. 73.650×10^{2} (which is of course equal to 7.3650×10^{3})

2. To transfer from a number less than 1 to a power of 10, move the decimal point to the right, as many places as desired, then write the resulting number x 10 raised to the minus power equal to the number of places you moved the decimal point. For example:

   a) 0.0000641
   Move the decimal point 5 places to the right to get 6.41. Then write x 10 to the minus 5 power.
   Ans. 6.41×10^{-5}

   b) 0.0000641
   Move the decimal point 8 places to the right to get 6,410. Then write x 10 to the minus 8 power.
   Ans. $6,410 \times 10^{-8}$ (which is equal to 6.41×10^{-5})

3. To transfer from one exponent of 10 to another, move the decimal place either to the right or to the left then change the exponent as follows: for every place to the right add -1 to the exponent; for every place to the left add +1 to the exponent. For example:

   a) 2.631×10^{3}
   Move the decimal point 2 places to the right, to get 263.1. Then add $^{-2}$ to the exponent. Since 3 + (-2) = 1, the new number is 263.1×10^{1}.

   b) 2.631×10^{3}
   Move the decimal point 3 places to the left, to get 0.002631. Then add +3 to the exponent. Since 3 + (+3) = 6, the number is 0.002631×10^{6} (which is equal to 263.1×10^{1}).

c) 6.52×10^{-5}
Move the decimal point 1 place to the right to get 65.2. Then add $^{-1}$ to the exponent. Since -5+(-1) = -6, the number is 65.2×10^{-6}.

d) 6.52×10^{-5}
Move the decimal point 2 places to the left to get 0.0652. Add +2 to the exponent. Since -5+(+2) = -3, the number is 0.0652×10^{-3} (which is equal to 65.2×10^{-6}).

4. To transfer from an exponential to normal number merely use rule 3 above, moving the decimal so that the exponent of 10 becomes 0; Since $10^{0} = 1$. For example:

a) 5.62×10^{4}
Move the decimal point 4 places to the right and add $^{-4}$ to the exponent of 10. [(+4)+(-4)=0].
Ans. $5,620 \times 10^{0}$ or $5,620 \times 1$ or merely 5,620.

b) 3.78×10^{-3}
Move the decimal point 3 places to the LEFT and add +3 to the exponent of 10.
Ans. $0.00378 \times 10^{0} = 0.00378 \times 1$ or merely 0.00378.

5. Adding or subtracting exponentials. Rewrite the number so that the exponents of 10 are the same, then add or subtract the number keeping the exponent in the answer the same . . that is DO NOT add or subtract the EXPONENTS. For example:

a) add 1.5×10^{4} to 3.0×10^{2}
solution:

$$\begin{array}{rl} 1.5 \times 10^{4} = & 150.0 \times 10^{2} \\ +3.0 \times 10^{2} = & +\ 3.0 \times 10^{2} \\ \hline & 153.0 \times 10^{2} \text{ or } 1.53 \times 10^{4} \end{array}$$

b) subtract 5×10^{-4} from 6×10^{-3}
solution:

$$\begin{array}{rl} 6 \times 10^{-3} = & 60 \times 10^{-4} \\ -5 \times 10^{-4} = & \ 5 \times 10^{-4} \\ \hline & 55 \times 10^{-4} \text{ or } 5.5 \times 10^{-3} \end{array}$$

6. Multiplying and Dividing Exponentials. To Multiply exponential numbers, merely multiply the numbers in front of the X 10 and then Add the exponents. To Divide, merely divide the numbers in front and then Subtract the exponents. For example:

Multiplication (add exponents)

a) $3 \times 10^{2} \times 2 \times 10^{3} = (3 \times 2) \times 10^{2+3} = 6 \times 10^{-5}$

b) $\frac{4 \times 10^{-4}}{2 \times 10^{-1}} \times 5 \times 10^{2} = (4 \times 5) \times 10^{-4+2} = 20 \times 10^{-2}$ or

Division (subtract exponents)

a) $\frac{2 \times 10^{5}}{1 \times 10^{3}} = \frac{2}{1} \times 10^{5-3} = 2 \times 10^{2}$

b) $\frac{8 \times 10^{-6}}{4 \times 10^{2}} = \frac{8}{4} \times 10^{-6-2} = 2 \times 10^{-8}$

c) $\frac{9 \times 10^{-3}}{3 \times 10^{-5}} = \frac{9}{3} \times 10^{-3-(-5)} = 3 \times 10^{2}$

NOTE

$(^{-3})$ minus $(^{-5})$ is equal to +2. If this is confusing, Division can be handled (with regard to the exponents) by bringing the exponent in the denominator (on the bottom) to the numerator (top) but also changing the sign. Then merely Add the exponents. For example as before:

d) $\frac{9 \times 10^{-3}}{3 \times 10^{-5}} = \frac{9}{3} \times 10^{-3 + (+5)} = 3 \times 10^{2}$

e) $\frac{6 \times 10^{4}}{6 \times 10^{-2}} = \frac{6}{6} \times 10^{4 + (+2)} = 1 \times 10^{6}$

f) $\frac{5 \times 10^{6}}{2 \times 10^{2}} = \frac{5}{2} \times 10^{6 + (-2)} = 2.5 \times 10^{4}$

Addendum

UNITS HAVING SERIAL NUMBER PREFIX -00

1. The following information applies only to MS-17's with the serial numbers prefixed with -00.

2. MS-17's with serial numbers prefixed with -01 (or higher) are to use this manual directly and to disregard this addendum.

3. The MS-17's whose serial numbers are prefixed with -00 utilize a Pirani guage and circuit which differs from -01 (or higher) prefixed units and are not interchangeable.

4. Units with prefix -00 use:

   a Circuit Board "D" (in lieu of "E" for -01 (or higher) prefixed units). P/N 1077-404-80

   b Pirani gauge (black case), P/N 5600-020-00

   c Crossover adjust R20/S9, P/N 1642-352-80

   d Meter-Manifold Pressure M2, P/N 1534-023-80

   e Figures 34, 35 and 20 (Sheet 3 only) for troubleshooting and reference.

   f Circuit Board "D" calibration instructions which follow.

CIRCUIT BOARD "D" CALIBRATION (See Figures 34 and 35)

With the electronic system connected to the vacuum system and the circuit breakers "ON"; calibrate the Pirani amplifier as follows:

1. Pump vacuum system down to a pressure lower than $1 \times (10)^{-4}$ torr. Preset cross-over (R20) point control (main panel) to center of its range (100 millitorr).

2. Adjust (R416) current source for 13mA at high vacuum - by connecting an accurate highiimpedance meter across R414, its reading should be 130 mV ± 1 mV.

3. Adjust the 2.4V control (R419), while observing Pirani meter so that meter pointer is just barely to the left of "1" millitorr.

4. Vent system completely. Allow at least thirty seconds before next step.

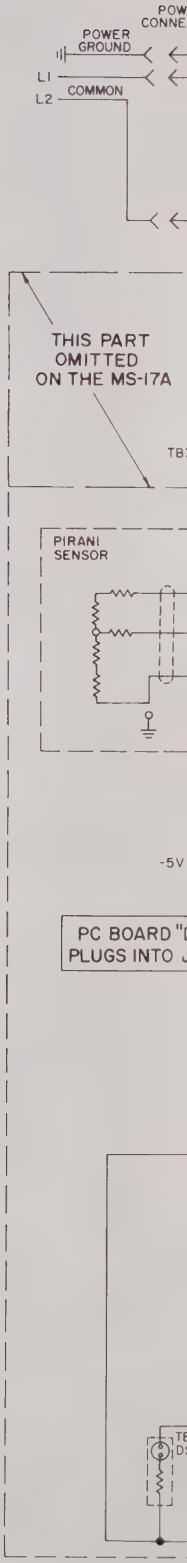
5. Adjust meter current pot (R423), so that meter pointer reads exactly over the "atm" division marking on the meter scale.

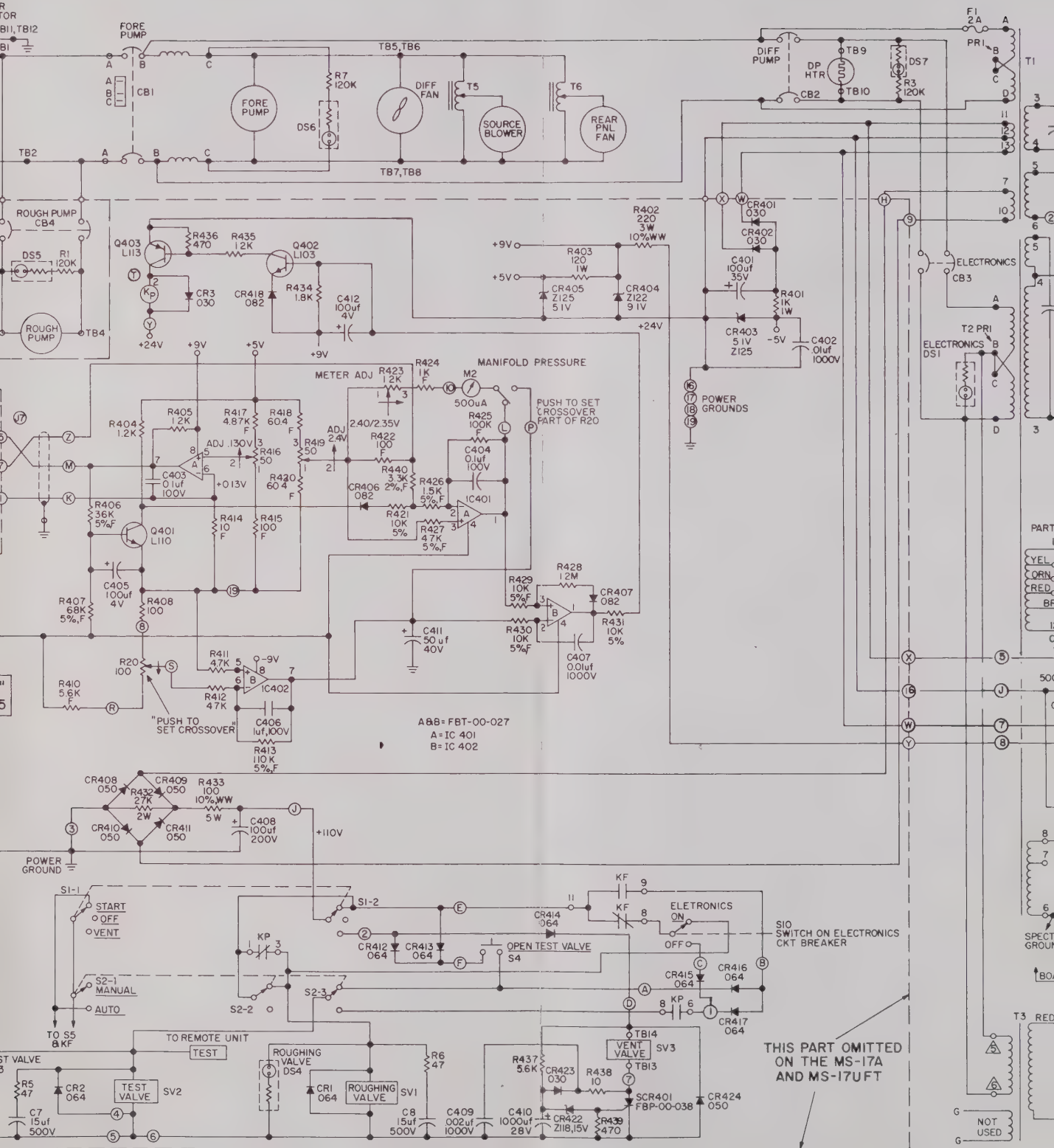
6. Pump system down to high vacuum as in step 1.

7. Check the 13 mA current to see that it has not changed from prior setting - If so repeat steps 2, 3, 4 and 5.

NOTES

1. RESISTOR VALUES IN OHMS, CAPACITOR VALUES IN MICROFARADS, UNLESS OTHERWISE NOTED
2. RESISTORS ARE COMPOSITION, 1/2 WATT UNLESS OTHERWISE NOTED.
3. RESISTOR TOLERANCES: COMP ±10%, FILM ±1%, WIREWOUND ±3% UNLESS OTHERWISE NOTED.
4. DIODE PART NUMBERS ARE PRECEEDED BY FBL-00 UNLESS OTHERWISE NOTED.
5. ZENER DIODE PART NUMBERS ARE PROCEEDED BY FBM- UNLESS OTHERWISE NOTED
6. TRANSISTOR PART NUMBERS ARE PRECEEDED BY FBN- UNLESS OTHERWISE NOTED.
7. LETTERS & NUMBERS -IN CIRCLE REFER T P.C. BD CONN
   -IN TRIANGLES REFER TO "C" BD SCREW CONN
   -NOT ENCLOSED REFER TO TERMINALS ON TRANSF, RELAY SOCKETS, OR SWITCHES.
8. ALL DESIGNATIONS ARE LAMBDA PART NUMBERS.
9. FOR 115V CONNECTIONS, CIRCUIT BREAKERS ARE SINGLE POLE. OMIT & SHORT CKT BKR IN "L2" LEG. OMIT T5, T6, R1, R3 & R7 & WIRE DIRECTLY ON T1 & T2 PRI REMOVE B-C JUMPER & CONN A TO B, C TO D
10. COMPONENT NOMENCLATURE .0-99 CHASSIS, 100-199 BD "A", 200-299 BD "B", 300-399 BD "C", 400-499 BD "D", 500-599 REM IND.




FORE PUMP
TB5,TB6
TB7,TB8
TB2
CB1
R7 120K
DS6
DIFF FAN
T5
T6
SOURCE BLOWER
REAR PNL FAN
DIFF PUMP
DP HTR
TB9
TB10
CB2
DS7
R3 120K
F1 2A
PRI
T1
ROUGH PUMP CB4
DS5
R1 120K
ROUGH PUMP
TB4
Q403 L113
R436 470
R435 1.2K
Q402 L103
CR3 030
CR418 082
R434 1.8K
C412 100uf 4V
+24V
+9V
+5V
R402 220 3W 10%WW
R403 120 1W
CR405 Z125 5.1V
CR404 Z122 9.1V
CR401 030
CR402 030
C401 100uf 35V
R401 1K 1W
CR403 5.1V Z125
C402 .01uf 1000V
-5V
ELECTRONICS CB3
T2 PRI
ELECTRONICS DS1
POWER GROUNDS
METER ADJ
R423 1.2K
R424 1K F
M2 500uA
MANIFOLD PRESSURE
PUSH TO SET CROSSOVER PART OF R20
R425 100K F
C404 0.1uf 100V
R404 1.2K
R405 1.2K
R417 4.87K F
R418 60.4 F
ADJ 2.40/2.35V
ADJ .130V
R419 50
R422 100 F
R416 50
R420 60.4 F
C403 0.1uf 100V
+0.13V
R440 3.3K 2% F
R426 1.5K 5% F
CR406 082
IC401
R421 10K 5%
R427 4.7K 5% F
R406 36K 5% F
Q401 L110
R414 10 F
R415 100 F
C405 100uf 4V
R407 68K 5% F
R408 100
R428 1.2M
R429 10K 5% F
CR407 082
R431 10K 5%
C411 50 uf 40V
R430 10K 5% F
C407 0.01uf 1000V
R20 100
R411 4.7K
R412 4.7K
IC402
-9V
C406 1uf,100V
R413 110K 5% F
"PUSH TO SET CROSSOVER"
R410 5.6K F
A&B= FBT-00-027
A= IC 401
B= IC 402
CR408 050
CR409 050
R433 100 10% WW 5W
R432 27K 2W
CR410 050
CR411 050
C408 100uf 200V
+110V
POWER GROUND
S1-1
START
OFF
VENT
S1-2
S2-1 MANUAL
AUTO
S2-2
S2-3
KP
CR412 064
CR413 064
CR414 064
OPEN TEST VALVE S4
KF
ELETRONICS ON
OFF
S10 SWITCH ON ELECTRONICS CKT BREAKER
CR415 064
CR416 064
CR417 064
TO S5 & KF
TO REMOTE UNIT
TEST
TEST VALVE SV2
R5 47
CR2 064
C7 15uf 500V
ROUGHING VALVE DS4
CR1 064
ROUGHING VALVE SV1
R6 47
C8 15uf 500V
C409 .002uf 1000V
TB14
VENT VALVE SV3
TB13
R437 5.6K
CR423 030
R438 10
SCR401 FBP-00-038
CR424 050
C410 1000uf 28V
CR422 Z118,15V
R439 470
THIS PART OMITTED ON THE MS-17A AND MS-17UFT
T3 RED
NOT USED
SPECT GROUN

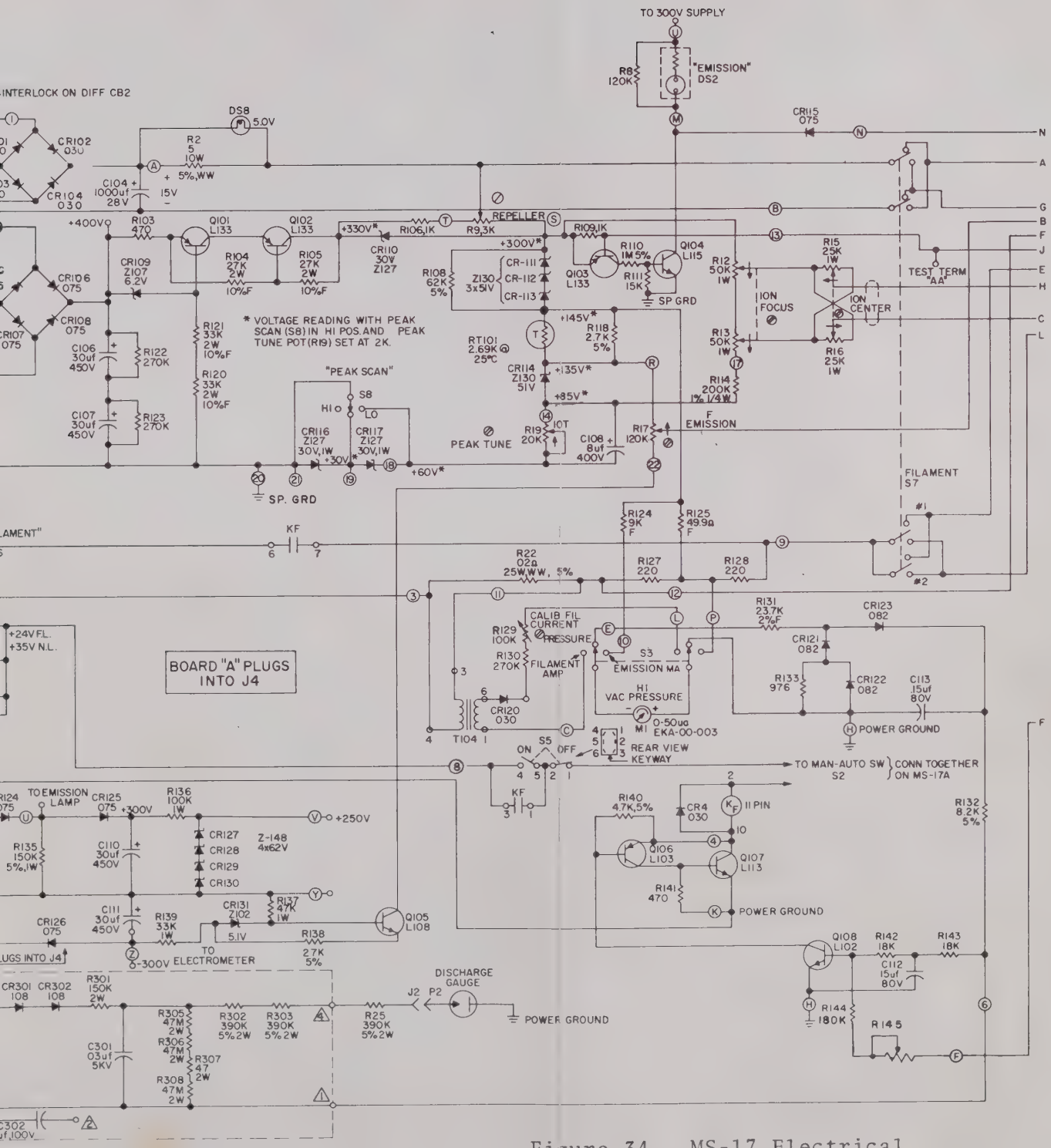
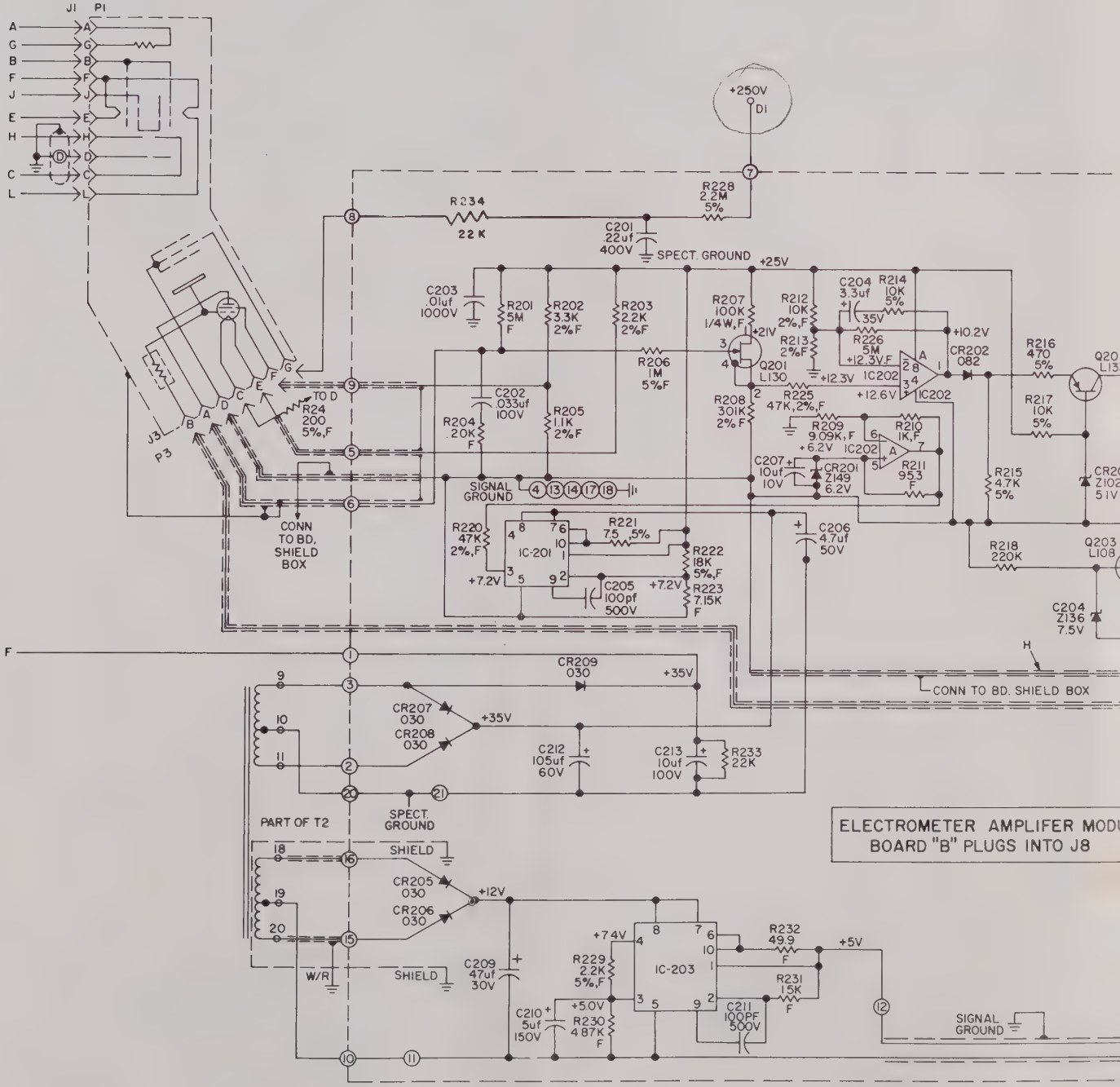


Figure 34. MS-17 Electrical Schematic, Serial Number Prefix -00 (Sheet 1 of 2)


J1 P1
A
G
B
F
J
E
H
D
C
L
+250V
D1
R234
22K
R228
2.2M
5%
C201
.22uf
400V
SPECT. GROUND
+25V
C203
.01uf
1000V
R201
5M
F
R202
3.3K
2%F
R203
2.2K
2%F
R206
1M
5%F
R207
100K
1/4W,F
+21V
R212
10K
2%,F
C204
3.3uf
35V
R214
10K
5%
R213
2%F
R226
5M
+12.3V,F
+10.2V
CR202
082
Q201
L130
+12.3V
R225
47K,2%,F
IC202
+12.6V
R216
470
5%
R217
10K
5%
R208
301K
2%F
R209
9.09K,F
+6.2V
R210
1K,F
C207
10uf
10V
CR201
Z149
6.2V
R211
953
F
R215
4.7K
5%
C202
.033uf
100V
R204
20K
F
R205
1.1K
2%F
TO D
R24
200
5%,F
J3
P3
SIGNAL GROUND
CONN TO BD. SHIELD BOX
R220
47K
2%,F
IC-201
R221
7.5 .5%
R222
18K
5%,F
R223
7.15K
F
+7.2V
C205
100pf
500V
C206
4.7uf
50V
R218
220K
Q203
L108
C204
Z136
7.5V
F
H
CONN TO BD. SHIELD BOX
CR209
030
+35V
CR207
030
CR208
030
C212
105uf
60V
C213
10uf
100V
R233
22K
PART OF T2
SPECT. GROUND
SHIELD
CR205
030
CR206
030
+12V
W/R
SHIELD
C209
47uf
30V
+7.4V
IC-203
R232
49.9
F
+5V
R231
1.5K
F
C210
5uf
150V
+5.0V
R230
4.87K
F
C211
100PF
500V
SIGNAL GROUND
ELECTROMETER AMPLIFER MODU
BOARD "B" PLUGS INTO J8

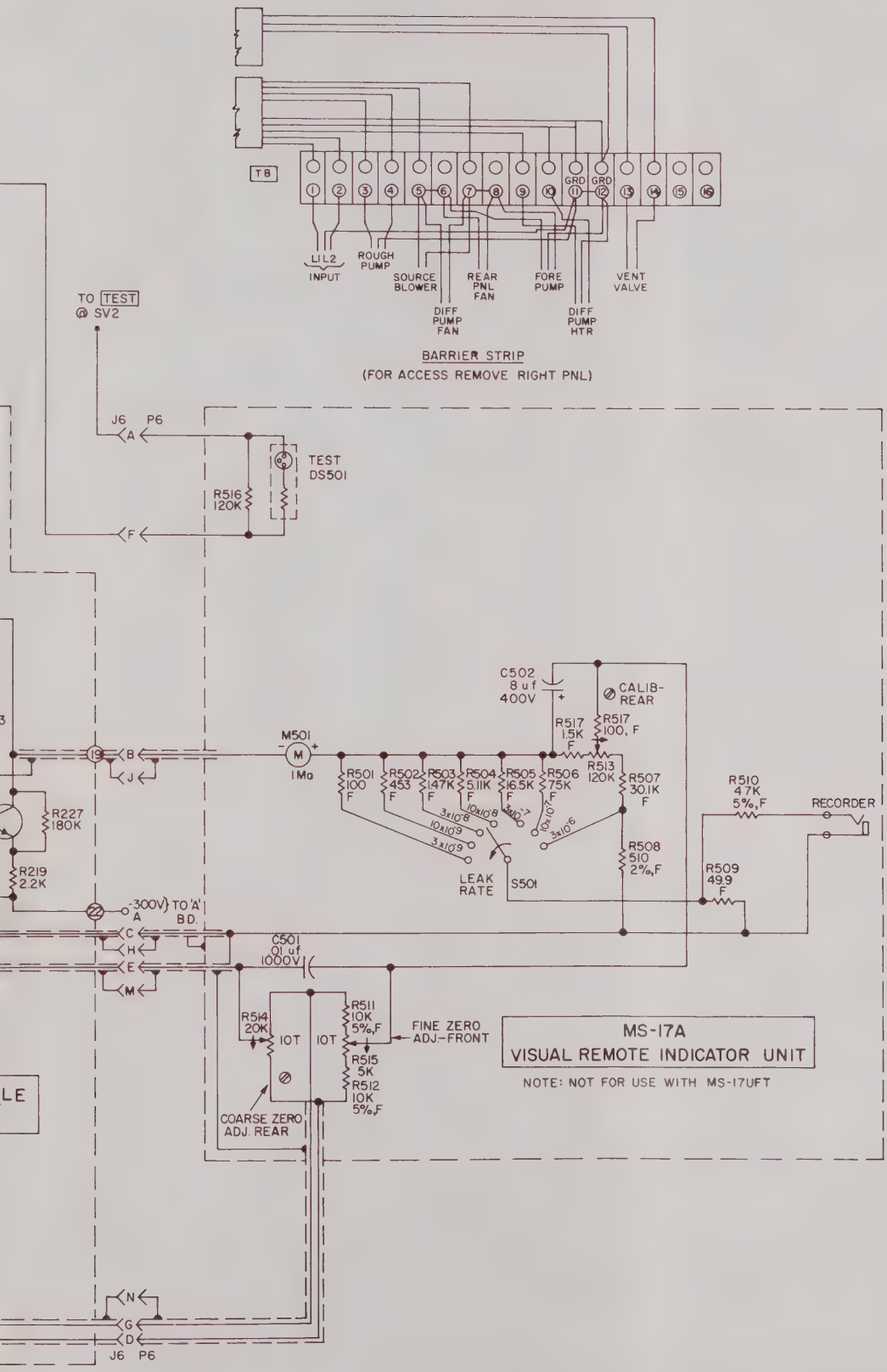
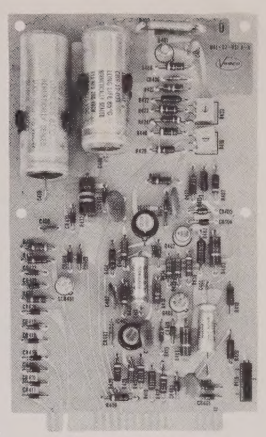


Figure 34. MS-17 Electrical Schematic, Serial Number Prefix -00
(Sheet 2 of 2)



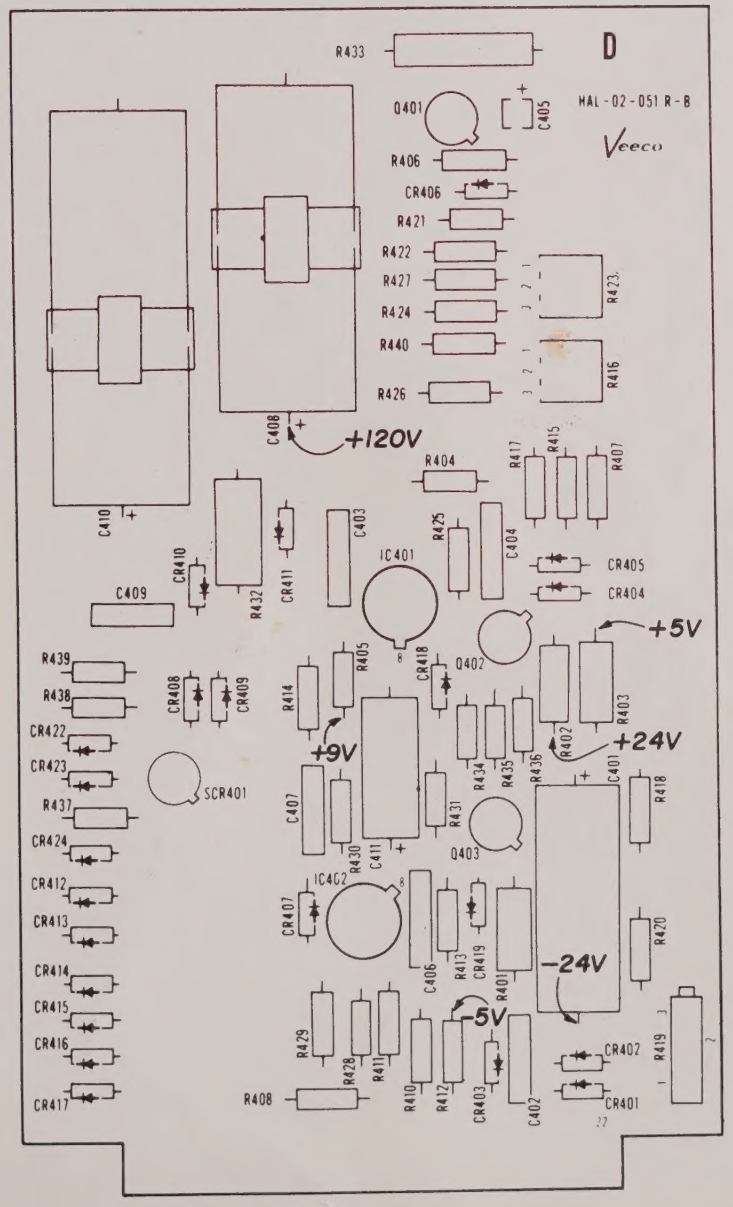


Figure 35. Circuit Board "D", Voltage Check Points

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